LOUISIANA COASTAL AREA (LCA)
ECOSYSTEM RESTORATION STUDY

Volume V of VI

Integrated Feasibility Study and
Final Environmental Impact Statement

for the

Terrebonne Basin Barrier Shoreline Restoration
Terrebonne Parish, Louisiana

October 2010

U.S Army Corps of Engineers
New Orleans District

Coastal Protection and
Restoration Authority

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The responsible lead Federal agency for this study is the U. S. Army Corps of Engineers- Mississippi Valley, New Orleans District (CEMVN). The non-Federal sponsor for the study is Coastal Protection and Restoration Authority (CPRA). This report is a combined feasibility report and environmental impact statement complying with requirements of the U.S. Army Corps of Engineers (USACE) and the Council of Environmental Quality (CEQ), and is intended to reduce duplication and paperwork. An asterisk (*) in the table of contents notes paragraphs that are required for the National Environmental Policy Act (NEPA) compliance.

October 2010

U.S Army Corps of Engineers
New Orleans District

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Integrated Feasibility Study and Final Environmental Impact Statement for the Terrebonne Basin Barrier Shoreline Restoration

LEAD AGENCY: United States Army Corps of Engineers – Mississippi Valley Division, New Orleans District

ABSTRACT: The United States Army Corps of Engineers (USACE), New Orleans District (CEMVN), proposes to restore approximately 1,272 acres of dune, supratidal, and intertidal habitat on the Terrebonne Basin Barrier Shoreline. Without action, this critical geomorphic feature that isolates the Terrebonne Basin estuaries from the Gulf of Mexico will continue to degrade, existing breaches will widen and new breaches will form, and portions of the Study Area will disappear in the near-term. Six alternative plans, including the No Action plan, were developed and evaluated as the Final Array. Alternative 5 (Raccoon with Terminal Groin (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / and Timbalier (Plan E)) was selected as the National Ecosystem Restoration (NER) Plan because it is a Best Buy plan that fulfills the planning objectives of the Study. The alternative increases the longevity of the geomorphologic form and ecologic function of the four islands in the Terrebonne Basin barrier system by creating a total of 472 acres of dune habitat, 4320 acres of supratidal habitat, and 1048 acres of intertidal habitat immediately after construction. However, the NER Plan cannot be constructed within the maximum project cost as authorized by Water Resources Development Act (WRDA) 2007 and modified according to section 902 of WRDA 1986, as amended. Therefore, Whiskey Plan C, a subset of the NER Plan, was selected as the first component of construction. The USACE will seek additional authorization in order to construct additional increments of the NER Plan. Immediately after construction (Target Year 1), the first component of construction will add 469 acres of habitat (dune, supratidal, and intertidal) to the existing island footprint, increasing the size of the island to 1,272 acres. The fully funded cost of the Whiskey Plan C is approximately $119,000,000, without renourishment. The two renourishment cycles will cost an additional $341,000,000. However, renourishment is considered an operation and maintenance cost that will be fully-funded by the non-Federal sponsor and does not count toward the maximum project cost of $189,900,000 as authorized by WRDA 2007 and modified according to section 902 of WRDA 1986.

Comments: Please send comments or questions on this Final Environmental Impact Statement (FEIS) to the United States Army Corps of Engineers, New Orleans District, Attention: William P. Klein, Jr., P.O. Box 60267, New Orleans, Louisiana 70160-0267. Telephone: (504) 862-2540; FAX: (504) 862-2088. **The official closing date for receipt of comments will be 30 days from the date on which the Notice of Availability of the FEIS appeared in the Federal Register.**

EXECUTIVE SUMMARY

ES 1 Summary Introduction and Study Information

The United Sates Army Corps of Engineers (USACE), Mississippi Valley Division, New Orleans District (CEMVN), proposes to restore approximately 1,272 acres of dune, supratidal, and intertidal habitat on the Terrebonne Basin Barrier Shoreline in lower Terrebonne and Lafourche Parishes, Louisiana. The Terrebonne Basin Barrier Shoreline is comprised of two barrier island reaches: the Isles Dernieres and the Timbalier Islands.

The Isles Dernieres reach includes Raccoon, Whiskey, Trinity, East, and Wine Islands. The Timbalier Island reach includes Timbalier and East Timbalier Islands. These barrier islands have undergone significant reductions in size due to a number of natural processes and human actions including lack of sediment, storm-induced erosion and breaching, subsidence, sea level rise and hydrologic modifications such as navigation and oil and gas canals. These habitat losses have had a direct adverse impact on wildlife and fisheries resources including threatened and endangered species. Loss of the barrier island habitat also leaves the fragile saline, brackish, and fresh marshes in the upper reaches of the Terrebonne Basin more vulnerable to the high energy marine coastal processes which have exacerbated wetland loss in these areas. The barrier islands also protect oil and gas infrastructure investments including hundreds of wells and pipelines which are of regional and national importance. Furthermore, numerical modeling has demonstrated that the barrier islands reduce storm surges which can mitigate the damage associated with tropical storms on human populations and infrastructure in Terrebonne and Lafourche Parishes.

Without action, these critical geomorphic features that isolate the Terrebonne Basin estuaries from the Gulf of Mexico will continue to degrade, existing breaches will widen and new breaches will form, and portions of the Study Area will disappear in the near-term. Raccoon, Whiskey, Trinity, East, and Wine Island are expected to completely disappear by 2052 if no action is taken. By 2062, Timbalier and East Timbalier will only have 6 acres of subaerial habitat left.

ES 2 Need for, and Objectives of Action *

Ecosystem restoration is one of the primary missions of the USACE Civil Works program. The USACE objective in ecosystem restoration planning is to contribute to National Ecosystem Restoration (NER) Plan. Contributions to national ecosystem restoration (NER outputs) are increases in the net quantity and/or quality of desired ecosystem resources. Measurement of the NER Plan is based on changes in ecological resource quality as a function of improvement in habitat quality and/or quantity and expressed quantitatively in physical units or indexes. These net changes are measured in the planning area and in the rest of the Nation.

Louisiana contains one of the largest expanses of coastal wetlands in the contiguous United States and accounts for 90% of the total coastal marsh loss occurring in the nation. The Terrebonne Basin Barrier Shoreline Restoration (TBBSR) Study Area is an essential ecosystem since it includes wetland habitats, essential fish habitat, and has high fish and wildlife values. The barrier islands protect the interior coastal wetlands, which also have high fish and wildlife value as well as great economic value as commercial and recreational fisheries. These ecosystems provide habitat for migratory birds, wildlife, finfish, shellfish, and other aquatic organisms including threatened or endangered species. Port Fourchon, located just east of the Study Area handles approximately 18% of the nation's oil supply and is the land base for the Louisiana Offshore Oil Port (LOOP). LOOP handles approximately 15% of the nation's foreign oil imports and is connected to 50% of the United States refinery capacity. The estuaries landward of the Terrebonne Basin Barrier Shoreline are productive oyster habitat and have traditionally supported important fisheries. The restoration of these barrier shorelines will protect these national assets from further degradation.

For the Louisiana Coastal Area (LCA) 2004 Study, two tiers of planning objectives were established – hydrogeomorphic and ecosystem objectives. The hydrogeomorphic objectives were:

- Establish dynamic salinity gradients that reflect natural cycles of freshwater availability and marine forcing.
- Increase sediment input from sources outside estuarine basins, and manage existing wetlands and rebuild marsh substrate.
- Maintain or establish natural landscape features and hydrologic processes that are critical to sustainable ecosystem structure and function.

The ecosystem objectives were:

- Sustain productive and diverse fish and wildlife habitats.
- Reduce nutrient delivery to the Continental shelf by routing Mississippi river waters through estuarine basins while minimizing potential adverse effects.

The LCA TBBSR Study objectives are a localized and project specific delineation of the LCA objectives. The Terrebonne Basin barrier shoreline is a unique ecosystem that helps to maintain the integrity of the gulf shoreline and protects the interior coast from further degradation. Aside from supporting coastal habitats, the coastal barrier chains in Louisiana are the first line of defense for protecting wetlands, inland bays, and mainland regions from direct effects of wind, waves, and storms. The barrier systems serve multiple defensive purposes to:

- Reduce coastal flooding during periods of storm surge.

- Prevent direct ocean wave attack, which would accelerate rates of erosion and degradation of marshes and other wetlands; and
- Help maintain gradients between saline and freshwater, thereby preserving estuarine systems.

Natural processes and human actions, such as the construction of oil field canals and the containment of waterways, have threatened the long-term viability of the Study Area. These processes and activities have caused significant adverse impacts to the Terrebonne Basin barrier island shoreline, resulting in extensive barrier island habitat loss and ecosystem degradation (USACE, 2004). Based on the function of these barrier islands and problems identified for the Terrebonne islands during this study, the following planning objectives were developed to assist the development and evaluation of alternative plans.

- Provide an expanded footprint of minimized barrier island sections to provide the geomorphic form and ecologic function of the Terrebonne Basin barrier island, reducing volume loss within the LCA TBBSR Study Area below the historic average (1880 through 2005)
- Restore and improve various barrier island habitats that provide essential habitats for fish, migratory birds, and other terrestrial and aquatic species, mimicking, as closely as possible, conditions which would occur naturally in the area for the 50 year period of analysis.
- Increase sediment input to supplement longshore sediment transport processes along the gulf shoreline by mechanically introducing compatible sediment, and increasing the ability of the restored area to continue to function and provide habitat for the 50 year period of analysis with minimum continuing intervention.

ES 3 Alternatives *

An initial list of measures was developed including 19 hard structural measures (i.e. revetments, groins, canal plugs, etc.) and 12 soft-structural measures (i.e. dune restoration, marsh creation, herbivore control, etc). Qualitative screening of these measures resulted in the elimination of 15 measures and the retention of 16 measures to be carried forward for a more detailed evaluation in the second level of screening. These management measures were determined to be consistent with specific USACE policies for ecosystem restoration, and Federal laws, regulations, and Executive Orders.

The second level screening effort built on the initial screening process, with an emphasis on the combinations of measures that could be used to meet the specific objectives of the Study. As a result of the second level of screening, it was determined that a combination of beach, dune, and marsh restoration measures would be needed to achieve the primary objective of restoring geomorphic form and ecologic function. This screening process resulted in the elimination of seven additional measures. The beach, dune, and marsh components, as well as the measures that could provide supplemental benefits were carried forward.

The final screening effort, which built upon the second level screening process, evaluated the use of supplementary measures including sand fences, vegetative planning, herbivory control, breakwaters, terminal groins, and continuous revetments that would complement the beach, dune, and marsh measures. These measures were evaluated on an island-by-island basis.

After screening of the measures, five restoration plans, each consisting of a beach, dune, and marsh component, were developed for the seven islands. The plans were denoted as Plans A through E:

- Plan A – No-Action Alternative
- Plan B – Minimum Design Plan
- Plan C – Minimum Design Plan plus 5 years of advanced fill
- Plan D – Minimum Design Plan plus 10 years of advanced fill
- Plan E – Minimum Design Plan plus 25 years of advanced fill

Various combinations of islands, restoration plans (Plans A through E) and supplementary measures (breakwaters, terminal groins, etc.) were evaluated to determine the best combinations of features (i.e. alternatives) that would meet the planning objectives and that would be consistent with the 2004 LCA Study and 2007 WRDA authorization. Through an iterative process of plan formulation and screening, six alternatives were originally recommended for inclusion in the Final Array of Alternatives. Each alternative is described below.

Alternative 1

Alternative 1, which is the No-Action Alternative, assumes there would be no future barrier island restoration within the Study Area. The barrier islands will continue to be subjected to the factors and processes that are contributing to the loss of the Timbalier and Isles Dernieres barrier island reaches and will result in a direct loss of the barrier islands to open water. By 2062, Timbalier and East Timbalier will only have 6 acres of subaerial habitat left. All other islands in the reach will have disappeared within the 50-year period of analysis.

Alternative 2

Alternative 2 includes the restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with 25 years of advanced fill. Approximately 2,630 acres would be restored for Alternative 2.

Alternative 3

Alternative 3 includes the restoration of Whiskey Island to its minimal geomorphologic form and ecologic function along with five (5) years of advanced fill combined with restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with twenty-five (25) years of advanced fill. Approximately 3,902 acres would be restored for Alternative 3.

Alternative 4

Alternative 4 includes the restoration of Whiskey and Trinity Islands to their minimal geomorphologic form and ecologic function along with five (5) years of advanced fill combined with restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with twenty-five (25) years of advanced fill. Approximately 5,051 acres would be restored for Alternative 4.

Alternative 5 (NER Plan)

Alternative 5 (NER Plan) includes the restoration of Raccoon Island to its minimal geomorphologic form and ecologic function along with twenty-five (25) years of advanced fill and construction of a terminal groin. This plan also includes restoration of Whiskey and Trinity Islands to their minimal geomorphologic form and ecologic function along with five (5) years of advanced fill and restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with twenty-five (25) years of advanced fill. Approximately 5,840 acres would be restored for Alternative 5 (NER Plan).

Alternative 11

Alternative 11 includes the restoration of Whiskey Island to its minimal geomorphologic form and ecologic function along with five (5) years of advanced fill. Approximately 1,272 acres would be restored for Alternative 11.

ES 4 Affected Environment *

The Study Area includes the Isles Dernieres and Timbalier Island reaches located in Terrebonne and Lafourche Parishes, Louisiana. These barrier islands define the southern boundary of the Terrebonne Basin and separate the shallow estuarine bays and saline marshes from the Gulf of Mexico.

Isles Dernieres

The Isles Dernieres reach is approximately 22 miles long and extends from Caillou Bay east to Wine Island Pass. Raccoon Island, Whiskey Island, Trinity Island, East Island, and Wine Island, the primary islands that comprise the Isles Dernieres barrier island reach, are backed by Bay Blanc, Bay Round, Caillou Bay, and Terrebonne Bay, and bordered by the Gulf of Mexico on the seaward side. The islands range from approximately 0.1 to 1.2 miles wide and are typically composed of a thin sand cap over a thick mud platform. Elevations are generally low and the islands are frequently overwashed.

Timbalier Islands

The Timbalier reach is comprised of Timbalier Island and East Timbalier Island. Timbalier and East Timbalier islands are on the western edge of the Lafourche barrier shoreline and are located about 60 miles southwest of New Orleans, Louisiana. This barrier island shoreline is approximately 20 miles long and backed by Terrebonne and Timbalier Bay to the north and delimited by Raccoon Pass to the east and Cat Island Pass to the west. The islands range from 0.1 to 0.6 miles wide, with low elevations. The Timbalier Islands support onshore and offshore oil and gas development and production. Oil and gas production facilities are prevalent in the East Timbalier Islands, while only a few scattered facilities are present along Timbalier Island. Oil and gas canals are present on both islands.

The impacts of the Deepwater Horizon oil spill on coastal Louisiana are uncertain at this time (October 2010). This spill could potentially adversely impact factors such as changes to existing or baseline conditions.

ES 5 Environmental Consequences *

Six alternative plans (including the No Action Alternative) were carried forward for detailed analysis based on the results of a cost effectiveness/incremental cost analysis (CE/ICA). Potential environmental consequences of implementing these alternatives were compared to the No-Action Alternative (Future Without Project Conditions). These alternatives were evaluated in terms of potential direct, indirect, and cumulative impacts to soils, hydrology, water quality and salinity, air quality, noise, vegetation resources, wildlife and habitat, aquatic resources, fisheries, essential fish habitat, threatened and endangered species, cultural resources, aesthetics, recreation, socioeconomics and human resources, and hazardous, toxic, and radioactive wastes. The following alternatives were evaluated:

- Alternative 1: No Action Alternative
- Alternative 2: Timbalier (Plan E) would restore a net total of 1100 average annual habitat units (AAHUs).
- Alternative 3: Whiskey (Plan C) / Timbalier (Plan E) would restore a net total of 1,778 AAHUs.
- Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E) would restore a net total of 2,406 AAHUs.

- Alternative 5 (NER Plan): Raccoon with TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E) would restore a net total of 2,883 AAHUs.
- Alternative 11: Whiskey (Plan C) would restore a net total of 678 AAHUs.

The impacts of the Deepwater Horizon oil spill on coastal Louisiana are uncertain at this time (October 2010). This spill could potentially adversely impact factors such as changes to Future Without and Future With Project conditions.

ES 6 Public Involvement *

The USACE published a notice of intent to prepare a Supplemental Environmental Impact Statement (SEIS) for the LCA TBBSR Study in the *Federal Register* on December 22, 2008. A public scoping meeting was held on February 10, 2009, in Houma, Louisiana. A Scoping Report was prepared that compiled comments received during the meeting as well as written comments submitted during the comment period.

In addition to the Scoping Meeting, Study updates were provided to the Terrebonne Parish Coastal Zone Committee and Restore or Retreat, a local non-governmental coastal advocacy group.

ES 7 Coordination and Compliance *

Following completion of the Final Integrated Feasibility Study and Final Environmental Impact Statement (FEIS), the Assistant Secretary of the Army for Civil Works will issue a Record of Decision (ROD) concerning the proposed action. Full compliance with statutory authorities will be accomplished upon review of the Final Integrated Feasibility Study (FEIS) by appropriate agencies and the public and the signing of the ROD, in compliance with the National Environmental Policy Act (NEPA). The USACE has coordinated with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and the Louisiana Department of Wildlife and Fisheries (LDWF) as per the Fish and Wildlife Coordination Act. A coordination act letter report has been received and the comments incorporated into the Integrated Feasibility Study and Final Environmental Impact Statement.

ES 8 Areas of Controversy and Unresolved Issues

An area of controversy that exists is the cost-effectiveness of hardened structures, most notably, rock breakwaters and revetments, in achieving the Study goals. These measures are supported by the local Parish Government as well as groups and individuals in the scientific community. Additionally, because the first component of construction does not stop the problems that cause coastal erosion, there is concern that it is not sustainable.

The impacts of the Deepwater Horizon oil spill on coastal Louisiana are uncertain at this time (October 2010). The impacts of the oil spill as well as the various emergency actions taken to address oil spill impacts (e.g., use of oil dispersants, creation of sand berms, use of Hesco baskets, rip-rap, sheet piling and other actions) could potentially impact USACE water resources projects and studies within the Louisiana coastal area, including the LCA TBBSR Study. Potential impacts could include factors such as changes to existing, Future Without, and Future With Project conditions, as well as increased project costs and implementation delays. The USACE will continue to monitor and closely coordinate with other Federal and State resource agencies and local sponsors in determining how to best address any potential problems associated with the oil spill that may adversely impact Study implementation. Supplemental planning and environmental documentation may be required as information becomes available. If at any time petroleum or crude oil is discovered on Study lands, all efforts will be taken to seek clean up by the responsible parties, pursuant to the Oil Pollution Act of 1990 (33 U.S.C. 2701 et seq.).

ES 9 Conclusions and Recommendations *

The NER Plan was selected because it represents a system-wide and cost-effective approach of restoring as many islands within the Terrebonne Basin barrier system which can be constructed with available sediment sources. A renourishment plan was also developed for the island to maintain their geomorphologic form and ecologic function throughout the 50-year period of analysis.

Alternative 5 (Raccoon with Terminal Groin (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / and Timbalier (Plan E)) was selected as the NER Plan because it is a Best Buy plan that fulfills the planning objectives of this study. Best Buy plans are the most efficient plans because they provide the greatest increase in output for the least increase in costs. The alternative restores the geomorphologic form and ecologic function of the four islands in the Terrebonne Basin barrier system. Immediately after construction (Target Year [TY] 1), the NER Plan will add 3,283 acres of habitat (dune, supratidal, and intertidal) to the existing island footprints of Raccoon, Whiskey, Trinity, and Timbalier Islands, increasing the total size of the islands to 5,840 acres. This includes approximately 472 acres of dune, 4,320 acres of supratidal habitat, and 1,048 acres of intertidal habitat. The NER Plan will require approximately 27.3 mcy of beach material and 18.7 mcy of marsh material for initial construction. This material will be dredged from a number of offshore borrow areas designated as South Pelto, Whiskey 3, New Cut, Raccoon, and Ship Shoal.

The creation of dune, supratidal, and intertidal habitats will provide essential habitats for fish, migratory birds, and other terrestrial and aquatic species. Furthermore, by using the proposed borrow areas, the project would increase sediment input to supplement longshore sediment transport processes along the gulf shoreline by mechanically introducing compatible sediment, and increasing the ability of the restored area to continue to function and provide habitat with minimum continuing intervention. Sediment placed on Trinity Island would eventually be transported to Whiskey Island and Raccoon Island as the sediment moves westward through the system. Raccoon Island would also receive sediment directly from Whiskey Island.

The NER Plan was also selected because it protects existing critical habitat on Raccoon and Whiskey Islands. Raccoon Plan E and Whiskey Plan C were designed to avoid approximately 58 and 286 acres of existing mangroves on the islands, respectively. This was done in order to minimize the ecologic impact during construction. Since these two islands are considered to be valuable wildlife habitats (Isles Dernieres Barrier Islands Wildlife Refuge) and the LDWF is reestablishing a pelican rookery on Whiskey Island, maintaining adequate areas of healthy beach, dune, and marsh is particularly important. Raccoon, Whiskey, Trinity, and Timbalier are also a critical habitat for endangered species including the piping plover and are a valuable stopover habitat for migratory birds.

In addition to protecting and maintaining precious ecological benefits, the NER Plan protects existing State investments on the island. For example, Whiskey Plan C was designed to complement TE-50, which is an existing Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) project that was constructed in 2009. TE-50 created approximately 316 acres of intertidal back-barrier marsh between the two existing mangrove stands. Restoration of the beach and dune gulfward of TE-50 will supplement the existing CWPPRA investment.

Raccoon Plan E was designed to complement two separate CWPPRA projects, TE-29 and TE-48. The TE-29 project, which was completed in July 1997, included the construction of eight segmented breakwaters along the eastern end of the island. The TE-48 project consists of two phases. Phase A, which included the construction of eight additional segmented breakwaters and a terminal groin on the eastern end of the island, was completed in September of 2005. Phase B, which is currently in the pre-construction phase, will include the construction of a 53-acre marsh along the backside of the island. The resilience of Raccoon Island Plan E is partially due to the existing breakwaters from both CWPPRA projects. The plan will help protected the marsh that will be constructed as part of TE-48.

The mangrove stands and CWPPRA projects on Raccoon and Whiskey Island can be avoided without undermining the project because they are the only areas of sufficient elevation to complement the design template and to contribute to the geomorphologic form and ecologic function of the islands. Avoidance of other pockets of existing habitat could potentially undermine the project by providing "weak spots" in the template. These areas could be more susceptible to breaching and could accelerate erosion. Therefore, the remaining 124 acres of habitat on

Raccoon Island and 201 acres on Whiskey Island will be covered with fill material during construction of the template. Existing habitat on Trinity and Timbalier Islands can not be avoided without undermining the project. Therefore, the entire footprints of the islands (564 acres on Trinity and 955 acres on Timbalier) will be covered with fill material, but will be restored through the vegetative planting efforts following construction.

Raccoon Island will be renourished at TY30 by adding adequate sediment such that the dune and supratidal beach acres would be equivalent to that of a newly constructed Plan B template. Whiskey Island will require two renourishment intervals. The first will occur at TY20 and will include the addition of the same amount of dune and supratidal beach habitat that was originally created in TY1. The second renourishment interval will occur at TY40 and will include the addition of the same amount of dune and supratidal beach habitat needed to construct a Plan B template. Trinity Island will be renourished at TY25 by adding the same amount of dune and supratidal beach habitat that was originally added in TY1. Timbalier Island will be renourished at TY30 by adding adequate sediment such that the dune and supratidal beach habitat acres would be equivalent to the acres of a newly constructed Plan B template.

However, the NER Plan cannot be constructed within the maximum project cost as authorized by WRDA 2007 and modified according to section 902 of WRDA 1986, as amended. Therefore, a subset of the NER Plan was selected as the first component of construction. The first component of construction represents an implementable and separable element of the NER Plan, is cost-effective, and within the cost and scope of the current authorization. The USACE will seek additional authorization in order to construct additional increments of the NER Plan. Due to the highly variable nature of the coastal processes within the Terrebonne Basin and the limitations of modeling barrier island restoration performance and response to structures with the modeling program completed in this study, it is recommended that combined wave and current modeling be conducted in the preconstruction, engineering, and design (PED) phase on a system-wide level to support the NER Plan.

In order to determine the first component of construction from the NER Plan, the PDT performed additional cost refinements on each island in the NER Plan. These analyses determined that Trinity Island Plan C and Whiskey Island Plan C were the only islands plans that could be constructed within the maximum project cost as authorized by WRDA 2007 and modified according to section 902 of WRDA 1986, as amended. Previous CE/ICA analysis revealed that both islands plans, when analyzed separately, were cost-effective. The plans also proved to be cost-effective when analyzed as a separate alternative (Alternatives 11 and 12) in the final array.

The barrier islands provide a critical component of the estuary structure, and are the first line of defense against marine and weather influences. Whiskey Island is the closest of the seven barrier islands to the critical marsh habitat located in the southern-most portion of Terrebonne Parish. If the island were to disappear, the marsh habitat on the mainland would be susceptible to the direct impacts of tropical storms and hurricanes.

Although Whiskey Plan C provides slightly fewer Average Annual Habitat Units (AAHUs) than Trinity Island Plan C (379 net AAHUs vs. 387 net AAHUs), it was selected as the first component of construction due to a number of qualitative benefits provided by the plan. Whiskey Plan C was designed to avoid approximately 286 acres of existing mangroves on the island in order to minimize the ecologic impact during construction. Since the island is considered a valuable wildlife habitat and the Louisiana Department of Wildlife and Fisheries (LDWF) is reestablishing a pelican rookery on the island, maintaining adequate areas of healthy beach, dune, and marsh is particularly important. The island is also a critical habitat for threatened species including the piping plover and is a valuable stopover habitat for migratory birds. Furthermore, Whiskey Plan C was designed to complement TE-50, which is an existing CWPPRA project that was constructed in 2009. TE-50 created approximately 316 acres of intertidal back-barrier marsh between the two existing mangrove stands. Restoration of the beach and dune gulfward of TE-50 will help to protect the existing CWPPRA project. Raccoon Island, which also contains a rare mangrove habitat and is an important rookery, will benefit from increased sediment deposition as the longshore sediment transport moves some of the sediment from Whiskey Island westward to Raccoon Island. Table ES-1 shows a comparison of the NER Plan and first component of construction alternatives.

Table ES-1: LCA TBBSR Study: Comparison of NER Plan and First Component of Construction

	Alt. 11 (First Component of Construction)	**Alt. 5 (NER Plan)**
Net AAHUs	678	2,883
Cost-effective (Yes/No/Best Buy)	Yes	Best Buy
$Annualized Cost/AAHU *	$10,740	$10,100
Project First Cost**	$113,000,000	$647,000,000
Federal Share Cost Total	$74,000,000	$421,000,000
Non-Federal Share Cost Total	$40,000,000	$226,000,000
Authorized Cost in WRDA Title VII, Section 7006 (e)(3)(A)		$124,600,000

	Alt. 11 (First Component of Construction)	**Alt. 5 (NER Plan)**
Maximum Cost Limited by Section 902***		$180,900,000
* Based on preliminary cost estimate, not MCACES cost. ** Includes MCACES costs plus contingency *** Includes inflation and monitoring and adaptive management costs.		

Immediately after construction (TY1), the first component of construction will add 469 acres of habitat (dune, supratidal, and intertidal) to the existing 803-acre island footprint, increasing the size of the island to 1,272 acres. This includes 65 acres of dune, 830 acres of supratidal, and 377 acres of intertidal habitat. Components of the first component of construction:

- Constructed dune to a height of +6.4 ft North American Vertical Datum (NAVD) 88 with dune crown of 100 ft
- Beach fill to an elevation of +4.2 ft NAVD 88 with a width of approximately 1300 ft on the gulfward side of the dune and a width of 100 ft on the bay side of the dune.
- Marsh fill (landward side of the dunes) to an elevation of +2.4 ft NAVD 88.
- Approximately 18,075 ft of sand fencing would be installed

Initial construction of the first component of construction will require 8.3 mcy of beach material dredged from Ship Shoal and 0.6 mcy of marsh material dredged from the Whiskey 3 borrow area.

The first component of construction meets the goal of the 2004 LCA Plan to address critical near-term needs for shoreline restoration for Terrebonne Basin through simulating historical conditions by enlarging the barrier island (width and dune crest) and reducing the current number of breaches to ensure the continuing geomorphic and ecological form and function of the barrier islands. The first component of construction also meets the USACE Principles and Guidelines of completeness, effectiveness, efficiency, and acceptability, as well as the Environmental Operating Principles of environmental sustainability, interdependence, balance and synergy, accountability, knowledge, respect, and assessing and mitigating cumulative impacts.

A renourishment event will be conducted on Whiskey Island in TY20 and in TY40 in order to maintain the geomorphic form and ecologic function of the island throughout the 50-year period of analysis.

The fully funded cost of the first component of construction is approximately $119,000,000, without renourishment. The two renourishment cycles will cost an additional $341,000,000. However, renourishment is considered an O&M cost that will be fully-funded by the non-Federal sponsor and does not count toward the maximum project cost of $180,900,000 as authorized by WRDA 2007 and modified according to section 902 of WRDA 1986, as amended.

TABLE OF CONTENTS

VOLUME V – TERREBONNE BASIN BARRIER SHORELINE RESTORATION INTEGRATED FEASIBILITY STUDY AND FINAL ENVIRONMENTAL IMPACT STATEMENT

APPENDICES

1.0 STUDY INFORMATION

1.1 STUDY AUTHORITY

Title VII of the Water Resources Development Act (WRDA) 2007 authorizes the Louisiana Coastal Area (LCA) ecosystem restoration program. Included within that authority are requirements for comprehensive coastal restoration planning, program governance, a Science and Technology Program, a program for the beneficial use of dredged material, feasibility studies for restoration plans, project modification investigations, and restoration project construction, in addition to other program elements. This authorization was recommended by the Chief of Engineer's Report, dated January 31, 2005.

Under Section 7006 of WRDA 2007, the LCA program has authority for feasibility-level reports of six near-term critical restoration features. The excerpt below from WRDA 2007 outlines the study authority for this report for the LCA Terrebonne Basin Barrier Shoreline Restoration (TBBSR) Study:

> ***SEC. 7003. LOUISIANA COASTAL AREA.***
> *(a) IN GENERAL.-The Secretary may carry out a program for ecosystem restoration, Louisiana Coastal Area, Louisiana, substantially in accordance with the report of the Chief of Engineers, dated January 31, 2005.*
>
> ***SEC. 7006. CONSTRUCTION.***
>
> *(3) PROJECTS SUBJECT TO REPORTS.—*
> *(A) FEASIBILITY REPORTS.—Not later than December 31, 2008, the Secretary shall submit to Congress feasibility reports on the following projects referred to in the restoration plan:*
> *(i) Multipurpose Operation of Houma Navigation Lock at a total cost of $18,100,000.*
> ***(ii) Terrebonne Basin Barrier Shoreline Restoration at a total cost of $124,600,000.***
> *(iii) Small Diversion at Convent/Blind River at a total cost of $88,000,000.*
> *(iv) Amite River Diversion Canal Modification at a total cost of $5,600,000.*
> *(v) Medium Diversion at White's Ditch at a total cost of $86,100,000.*
> *(vi) Convey Atchafalaya River Water to Northern Terrebonne Marshes at a total cost of $221,200,000.*
> *(B) CONSTRUCTION.—The Secretary may carry out the projects under subparagraph (A) substantially in accordance*

> *with the plans and subject to the conditions, recommended in a final report of the Chief of Engineers if a favorable report of the Chief is completed by not later than December 31, 2010.*
> *(4) CONSTRUCTION.—No appropriations shall be made to construct any project under this subsection if the report under paragraph (2) or paragraph (3), as the case may be, has not been approved by resolutions adopted by the Committee.,*

This report is an integrated feasibility study and final environmental impact statement (FEIS) conducted for the LCA TBBSR Study. This report fulfills the reporting requirement to Congress of Section 7006(e)(3) which directs the Secretary of the Army to submit feasibility reports on the six projects included in that section by December 31, 2008 and authorizes implementation of the projects provided a favorable Chief of Engineers' Report is completed no later than December 31, 2010.

1.2 PURPOSE AND SCOPE

The purpose of the proposed action is to address the goal of the 2004 LCA Plan; specifically, to address the critical near-term needs for shoreline restoration in Terrebonne Basin through simulation of historical conditions, which will be achieved by enlarging the existing barrier islands (width and dune crest) and reducing the current number of breaches. Additional objectives include analyzing the current conditions of the barrier islands, assessing impacts from the hurricanes of 2005 and 2008, and reaffirming the validity of the findings of the Final Environmental Impact Statement (FEIS) (USACE, 2004b).

The Integrated Feasibility Study and FEIS is based on a thorough review of existing scientific and engineering reports, as well as geospatial, survey, and geotechnical data. The report provides a description of the planning process used to identify the National Ecosystem Restoration (NER) Plan and first component of construction; identifies implementation responsibilities and cost estimates; and presents a recommendation for construction of the LCA TBBSR Study. Project planning was of sufficient scope and detail to effectively quantify the impacts of the NER Plan and first component of construction. The Study considers all reasonable alternatives including alternatives considered in previous studies, alternatives of varying widths and configurations of barrier shorelines, consideration of marsh restoration as a platform for barrier shoreline rollover, and recommendations from interested parties submitted during scoping, public, and stakeholder meetings.

1.3 STUDY AREA

The Study Area, located in LCA Subprovince 3, provides for the restoration of the Isles Dernieres and Timbalier Island reaches located in Terrebonne Parish and

Lafourche Parish, Louisiana. The Study Area is located in the 3rd Congressional District. The Study Area is shown on Figure 1-1.

1.3.1 Isles Dernieres Reach

The Isles Dernieres Reach represents a barrier island arc approximately 22 miles long in Terrebonne Parish and extends from Caillou Bay east to Cat Island Pass. Raccoon Island, Whiskey Island, Trinity Island, East Island, and Wine Island, the primary islands that comprise the Isles Dernieres barrier island reach, are backed by Bay Blanc, Bay Round, Caillou Bay, and Terrebonne Bay, and bordered by the Gulf of Mexico (GOM) on the seaward side. The islands range from approximately 0.1 to 1.2 miles wide and are generally composed of a thin sand cap over a thick mud platform. Elevations are generally low and the islands are frequently overwashed (USACE, 2004c).

The Isles Dernieres have been and continue to be an important commercial and recreational resource for Louisiana and the nation for more than 150 years. The islands support habitats that are critical to the State's commercial fishing industry. Furthermore, the mineral-rich subsurface below Terrebonne Bay, Lake Pelto, and Timbalier Bay has supported a high concentration of oil and gas wells.

The first major coastal resort in Louisiana was located here and was washed away by the great hurricane of 1856 (USACE, 2004c). The Isles Dernieres are also the location of five Coastal Wetland Planning, Protection, and Restoration Act (CWPPRA) projects. These projects included: Raccoon Island (TE-29), Whiskey Island (TE-27), Trinity Island (TE-24), East Island (TE-20), and New Cut (TE-37).

1.3.2 Timbalier Reach

The Timbalier Reach is comprised of Timbalier Island and East Timbalier Island. The two islands are on the western edge of the Lafourche barrier shoreline and are located about 60 miles southwest of New Orleans, Louisiana (Figure 1-1). This barrier island shoreline is approximately 20 miles long and backed by Terrebonne and Timbalier Bay to the north and delimited by Raccoon Pass to the east and Cat Island Pass to the west. The islands range from 0.1 to 0.6 miles wide and have low elevations. The Timbalier Islands support onshore and offshore oil and gas development and production. Oil and gas production facilities are prevalent along East Timbalier Island, while only a few scattered facilities are present along Timbalier Island. Oil and gas canals are present on both islands (USACE, 2004c).

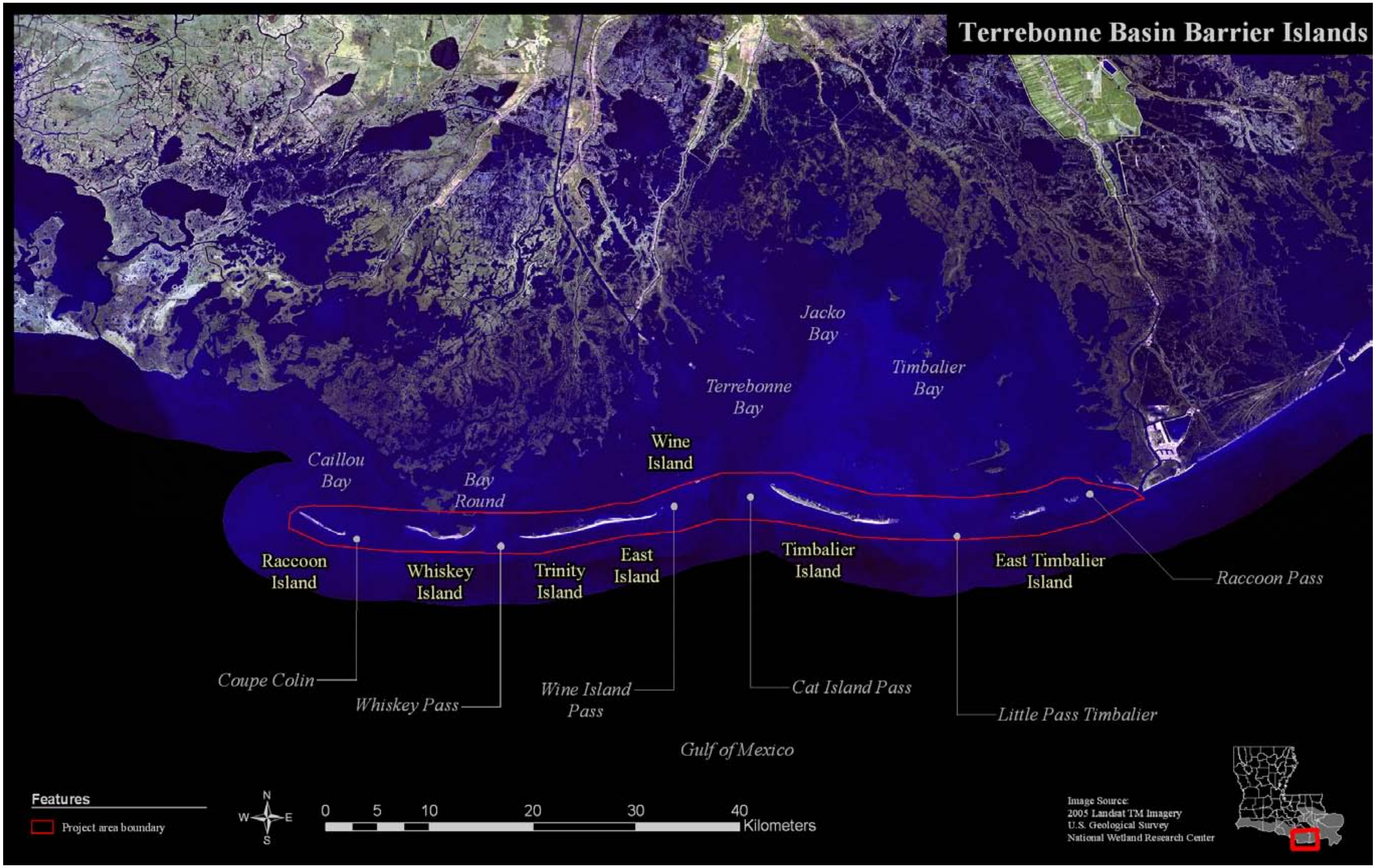

Figure 1-1. Terrebonne Basin Barrier Shoreline Restoration Study Area

1.4 History of Investigation

This study was designed to address general barrier island and estuarine ecosystem restoration problems and opportunities in the Study Area. Numerous regional and site-specific investigations of erosion and shoreline loss have been conducted along the Terrebonne Basin barrier island chains. Five of the most comprehensive studies conducted are listed below:

- Coast 2050 Plan: Toward a Sustainable Coastal Louisiana (LDNR, 1989);
- LCA, Louisiana Ecosystem Restoration Study (USACE, 2004a);
- Louisiana Coastal Protection and Restoration (LACPR) Final Technical Report (USACE, 2009);
- Ecosystem Restoration and Hurricane Protection in Louisiana (CPRA, 2007); and
- Evaluation and Recommendation of the Barrier Shoreline Feasibility Study (T. Baker Smith, 1997).

These comprehensive planning studies are discussed below. Planning for this Study utilized data from these reports and alternative plans were formulated in coordination with these plans.

1.5 Prior Studies, Reports, and Existing Projects

A number of prior water resources development efforts are relevant to the LCA Program. Restoration feature type and location, engineering design, construction techniques, and performance metrics from these prior efforts have been assessed and are being considered throughout the project plan formulation process. Table 1-1 lists these efforts and denotes how each is relevant to the LCA TBBSR Study.

Table 1-1. Relevance of Prior Studies, Reports, Programs, and Water Projects to the LCA TBBSR Study

Prior Studies, Reports, Programs, and Water Projects	Relevance to Terrebonne Basin Barrier Shoreline Restoration			
	Data Source[a]	Consistency[b]	Hard-Structural Measures[c]	Soft-Structural Measures[d]
Comprehensive Planning Studies				
Coast 2050 Plan, 1999	X	X	X	X
Louisiana Coastal Area (LCA), Louisiana Ecosystem Restoration Study, 2004	X	X	X	X
Louisiana's Comprehensive Master Plan for a Sustainable Coast, 2010	X	X	X	X
Louisiana Coastal Protection and Restoration (LACPR) Technical Plan, 2009	X	X	X	
Ecosystem Restoration and Hurricane Protection in Louisiana (CPRA), 2007	X	X	X	X
Barrier Island Plan, Evaluation and Recommendation of the Barrier Shoreline Feasibility Study, T. Baker Smith, 1997	X	X	X	X
Prior Studies, Reports and Water Projects				
CWPPRA TE-18, Timbalier Island Planting Demonstration, NRCS, Completed 1996	X	X	X	X
CWPPRA TE-20, Isles Dernieres Restoration of East Island, EPA, Completed 1999	X	X	X	X
CWPPRA TE-24, Isles Dernieres Restoration of Trinity Island, EPA, Completed 1999	X	X	X	X
CWPPRA TE-25, East Timbalier Island Sediment Restoration, Phase 1, NMFS, Completed 2000	X	X	X	X
CWPPRA TE-30, East Timbalier Island Sediment Restoration, Phase 2, NMFS, Completed 2000	X	X	X	X
CWPPRA TE-27, Whiskey Island Restoration, EPA, Completed 2000	X	X		X
CWPPRA TE-29, Raccoon Island Breakwater Demonstration, NRCS, Completed 1997	X	X	X	
CWPPRA TE-37, New Cut Dune and Marsh Restoration,	X	X	X	X

Prior Studies, Reports, Programs, and Water Projects	Relevance to Terrebonne Basin Barrier Shoreline Restoration			
	Data Source[a]	Consistency[b]	Hard-Structural Measures[c]	Soft-Structural Measures[d]
EPA, Completed 2007				
CWPPRA TE-40, Timbalier Island Dune and Marsh Creation, EPA, Completed 2004	X	X	X	X
CWPPRA TE-47, Ship Shoal – Whiskey West Flank Restoration, EPA, Currently in Engineering & Design	X	X	X	X
CWPPRA TE-48, Raccoon Island Shoreline Protection / Marsh Creation, NRCS, Under Construction	X	X	X	X
CWPPRA TE-50, Whiskey Island Back-Barrier Marsh Creation, EPA, Construction Funds Awarded	X	X	X	X
CWPPRA TE-52, West Belle Pass Barrier Headland Restoration, NMFS/COE, Currently in Engineering & Design	X	X		X
CWPPRA TE-53, Enhancement of Barrier Island Vegetation Demonstration, EPA,		X		X
CIAP Nomination – Raccoon Island Breakwaters		X	X	
CIAP Nomination – East Timbalier Island Sediment Restoration		X		X
CIAP Nomination – Ship Shoal: Whiskey West Flank Restoration	X	X	X	X
CIAP Nomination – Beach and Back Barrier Marsh Restoration, East and Trinity Islands		X		X
CIAP Nomination – Wine Island Restoration		X		X
CIAP Nomination – East Island Beach, Dune & Marsh Restoration		X		X
CIAP Nomination – East Timbalier Island (Eastern Section) Restoration		X		X
CIAP Nomination – East Timbalier Island Restoration		X		X
USACE Navigation Projects – Houma Navigation Canal	X	X		X
Beneficial Use of Dredged Material		X		X
Scoping Study to Evaluate Deepening of Houma Navigation Channel at Cat Island Pass, Louisiana,	X	X		X

Prior Studies, Reports, Programs, and Water Projects	Relevance to Terrebonne Basin Barrier Shoreline Restoration			
	Data Source[a]	Consistency[b]	Hard-Structural Measures[c]	Soft-Structural Measures[d]
USACE, 2008				
Environmental Assessment – Issuance of Non-Competitive Leases for the use of Outer Continental Shelf Sand Resources from Ship Shoal, Offshore Central Louisiana for Coastal and Barrier Island Nourishment and Hurricane Levee Construction, MMS, Draft - 2004	X	X		X
Laws and Programs				
The Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA), 1990	X	X	X	X
USACE Continuing Authorities Program, 1996				X
The Coastal Impact Assistance Program (CIAP), 2001 & 2005	X	X	X	X
Second Emergency Supplemental Appropriations Act to Meet the Immediate Needs Arising from the Consequences of Hurricane Katrina, 2005 (Public Law 109-062)	X	X		
Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006 (Public Law 109-148)	X	X	X	X
Louisiana Coastal Wetlands Conservation, Restoration and Management Act, 1989		X		
Act 8 of the First Extraordinary Session of 2005 (CPRA)	X	X		

[a] Relevance of LCATBBSR Study data sources to data sources of prior projects
[b] Consistency of LCA TBBSR Study measures with prior projects
[c] Relevance of LCA TBBSR Study hard-structural measures including breakwaters, revetments, groins, terminal groins, barges/ships, sand fencing, sheet pile, pass closures, and canal plugs, to hard-structural measures of prior projects
[d] Relevance of LCA TBBSR Study soft-structural measures including dune/beach restoration, marsh creation, beach nourishment, subtidal sediment placement, beach closure, vegetation planting, oyster reefs, spit creation, and canal backfilling to soft-structural measures of prior projects

1.5.1 Federal

1.5.1.1 Coast 2050 Plan, 1999

In 1998, Federal and State agencies, local governments, academia, numerous non-governmental groups, and private citizens participated in developing the Coast 2050 Plan (LDNR, 1989), a conceptual plan for restoration of the Louisiana coast. The Plan was a direct outgrowth of lessons learned from implementation of restoration projects through CWPPRA and other related programs, and reflected a growing recognition that a more comprehensive "systematic" approach to restoring coastal wetlands was needed. The Plan formed the basis for the May 1999 905(b) reconnaissance report that preceded the LCA Ecosystem Restoration Study.

1.5.1.2 LCA Ecosystem Restoration Study, 2004

In 2000, the USACE and State of Louisiana initiated the 2004 LCA Plan to address Louisiana's severe coastal land loss problem. The goal of the 2004 LCA Plan is to achieve and sustain a coastal ecosystem that can support and protect the environment, economy, and culture of coastal Louisiana and thus, contribute to the economy and well-being of the Nation. The 2004 LCA Plan focused on "lessons learned" from previous Louisiana coastal restoration efforts, the Coast 2050 restoration strategies, and the best available science and technology to develop a plan addressing the most critical coastal ecological needs. A Final Programmatic Environmental Impact Statement (FPEIS) was prepared for this study. The Record of Decision (ROD) for the FPEIS was signed on November 18, 2005. The FPEIS is hereby incorporated by reference.

The LCA plan maximizes the use of restoration strategies that reintroduce historic flows of river water, nutrients, and sediment to coastal wetlands, and that maintain the structural integrity of the coastal ecosystem. Execution of the 2004 LCA Plan would make significant progress towards achieving and sustaining a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus, contribute to the economy and well-being of the Nation (USACE, 2004a). The 2004 LCA Plan included:

- Specific authorization for implementation of five near-term critical restoration features for which construction can begin within 5 to 10 years, subject to approval of feasibility-level decision documents by the Secretary of the Army;
- Programmatic Authorization of a Science and Technology Program;
- Programmatic Authorization of Science and Technology Program Demonstration Projects;
- Programmatic Authorization for the Beneficial Use of Dredged Material;
- Programmatic Authorization for Investigations of Modification of Existing Structures;

- Approval of ten (10) additional near-term critical restoration features and authorization for investigations to prepare necessary feasibility-level reports to be used to present recommendations for potential future Congressional authorizations; and
- Approval of investigations for assessing six potentially promising large-scale and long-term restoration concepts.

The LCA TBBSR Study was selected as one of the near-term critical restoration features for which construction could begin within 5 to 10 years. This feature originally considered restoration elements for all the major reaches of the Terrebonne barrier shoreline, however, for inclusion in the near-term plan some consideration was given to the most critically needed elements of the reach. This restoration feature provides for the restoration of the Isles Dernieres and Timbalier Island reaches. This would simulate historical conditions by reducing the current number of breaches, enlarging (width and dune crest) of the Isles Dernieres and Timbalier Islands.

1.5.1.3 LACPR Technical Plan, 2009

In response to the destruction caused by Hurricanes Katrina and Rita, the U.S. Congress directed the Secretary of the Army to develop plans for hurricane risk reduction and coastal restoration in both Louisiana and Mississippi. In Louisiana, Congress directed the Secretary of the Army (Public Laws 109-103 and 109-148), acting through the Chief of Engineers, to:

- Conduct a comprehensive hurricane protection analysis and design in close coordination with the State of Louisiana and its appropriate agencies;
- Develop and present a full range of flood control, coastal restoration, and hurricane protection measures exclusive of normal policy considerations for South Louisiana;
- Consider providing protection for a storm surge equivalent to a Category 5 hurricane; and
- Submit preliminary and final technical reports.

The LACPR Final Technical Report was prepared by the USACE New Orleans District in response to the Congressional direction for Louisiana. The identification, selection, and implementation of comprehensive, long range plans for the reduction and management of hurricane storm damage risk is a highly complex and collaborative effort. Decisions on these plans will require a high level of engagement and cooperation at the Federal, State, local, and even individual level. The technical information to inform some of these long-term decisions is now available through the LACPR report. Congress directed a technical report rather than a reconnaissance or feasibility report as described by normal USACE policy. The LACPR report presents an array of alternatives for further consideration and informs decision makers, stakeholders, and the public of the tradeoffs among these alternatives that should be considered in future decisions in order to maintain existing risk levels and/or reduce risk along the Louisiana coast.

1.5.1.4 Barrier Shoreline Feasibility Study, 1997

The Barrier Shoreline Feasibility Study (T. Baker Smith, 1992) is the result of a multi-year barrier shoreline feasibility study authorized by CWPPRA, covering the barrier islands between the Atchafalaya and Mississippi Rivers. The Final Report brought together the 12 individual reports that addressed the 11 steps of the feasibility study. The study addressed both qualitative and quantitative aspects of the natural/environmental and socioeconomic resources, forecasted trends in those resources if no actions are taken, identified and assessed various management alternatives to solve the identified problems, identified various available engineering solutions to implement the management alternatives, estimated their costs, and recommended plans for four islands or reaches.

1.5.1.5 CWPPRA

While the Federal government has been concerned with and involved in Louisiana's coastal land loss problem for decades, enactment of CWPPRA in 1990 marked the first Federal statutory mandate for restoration of Louisiana's coastal wetlands. CWPPRA is described in the Related Laws and Programs section below.

The CWPPRA mandates preparation of an annual Priority Projects List (PPL). These lists consist of projects that address gulf and inland shoreline protection, sediment and freshwater diversions, terracing, vegetative plantings, marsh creation, hydrologic restoration, marsh management, and barrier island restoration. In the initial stages of the CWPPRA program, the PPL consisted primarily of projects that were considered under the original Louisiana Coastal Wetlands Restoration Plan (1992), but later included projects that were nominated or proposed by the Interagency Planning or Citizen Participation Groups. Once nominated, these projects are screened and the resulting candidate projects undergo additional costs and environmental benefits evaluations prior to consideration for the PPL (LDNR, 1997). In fiscal 2009, CWPPRA received approximately $90 million of Federal funding for the planning and construction of coastal protection and restoration projects (Gay Browning, personal communication, April 2009).

The following projects located within the Study Area have either been constructed, are in the engineering and design phase, or are awaiting Phase I/II Authorization (Figure 1-2):

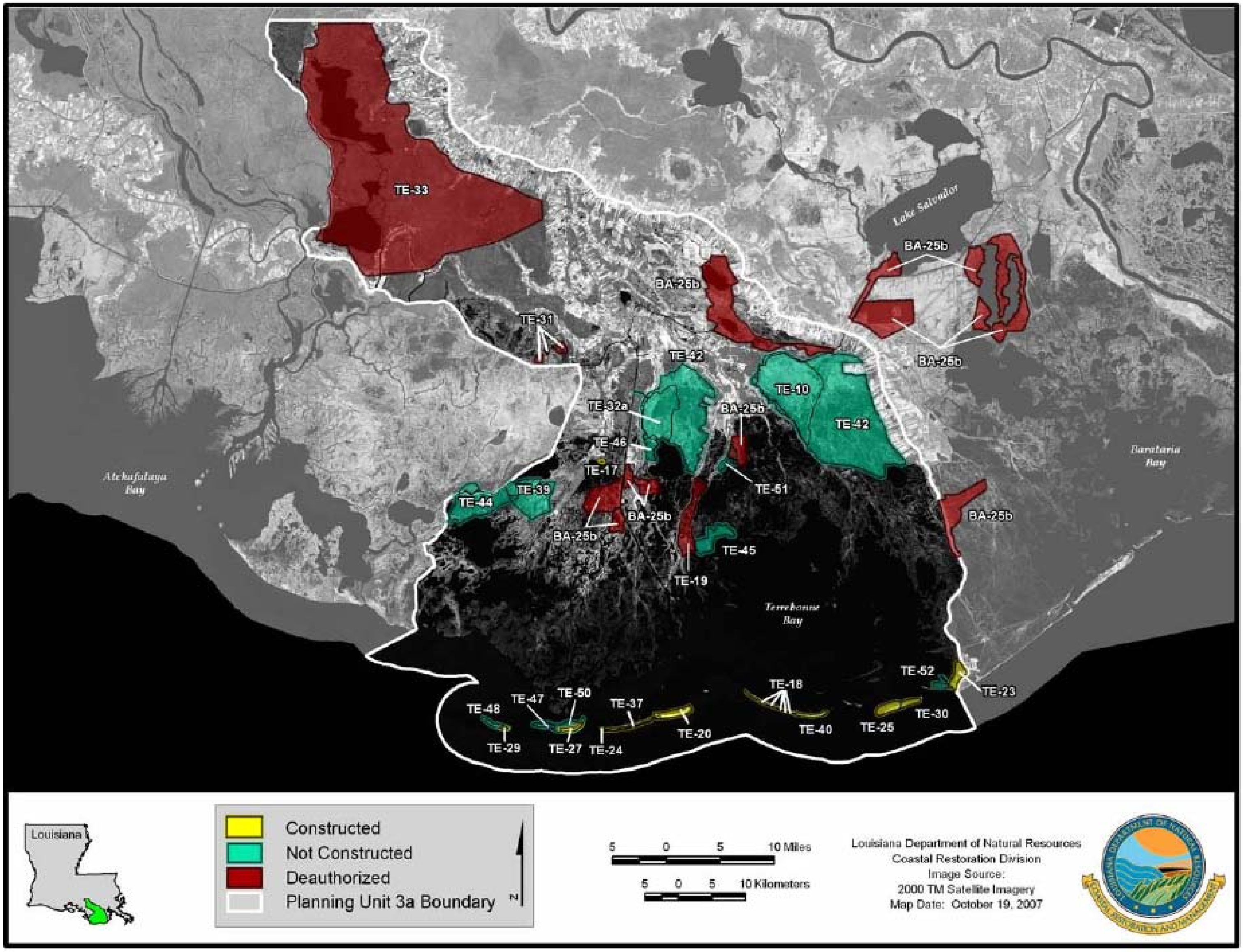

Figure 1-2. Location of CWPPRA Projects that have been Authorized in Planning Unit 3a

CWPPRA Projects That Have Been Constructed

TE-18	Timbalier Island Planting Demonstration	Completed July 1996
TE-20	Isles Dernieres Restoration East Island	Completed June 1999
TE-24	Isles Dernieres Restoration Trinity Island	Completed June 1999
TE-25	East Timbalier Island Sediment Restoration	Phase 1 Completed Jan. 2000
TE-27	Whiskey Island Restoration	Completed June 2000
TE-29	Raccoon Island Breakwater Demonstration	Completed July 1997
TE-30	East Timbalier Island Sediment Restoration	Phase 2 Completed Jan. 2000
TE-37	New Cut Dune and Marsh Restoration	Completed July 2007
TE-40	Timbalier Island Dune and Marsh Creation	Completed Dec. 2004
TE-48	Raccoon Island Shoreline Protection/Marsh Creation	Phase A Completed Sept. 2005
TE-50	Whiskey Island Back Barrier Marsh Creation	Completed Sept. 2009

CWPPRA Projects Authorized for Construction

TE-48	Raccoon Island Shoreline Protection/Marsh Creation-Phase B	Pre-Construction

CWPPRA Projects Waiting Phase I/II Authorization

TE-47	Ship Shoal: Whiskey West Flank Restoration	Engineering & Design
TE-52	West Belle Pass Barrier Headland	Beginning Engineering and Design
TE-53	Enhancement of Barrier Island Vegetation Demonstration	Waiting Phase

A brief summary of each CWPPRA project is presented herein. Additional information (project location, restoration feature types, cost, benefits, and year of completion) related to these projects can be found in the Louisiana Coastal Wetlands Conservation and Restoration Task Force General Fact Sheets. It should be noted that most CWPPRA projects do not provide funding for long-term post-construction monitoring and limited post-construction monitoring is accomplished by the Office of Coastal Protection and Restoration (OCPR) when funding becomes available. Success of CWPPRA projects is difficult to ascertain in some instances.

TE-18 Timbalier Island Plantings Demonstration

TE-18 was a sand fence demonstration project that included vegetative plantings along approximately 7,400 linear ft of the gulf shoreline of Timbalier Island. The goals of the project were to increase the elevation of the island and its vegetation cover through the use of sand fencing and vegetative plantings or combinations of both. The project was completed in July 1995 with additional plantings conducted in July 1996. Results of the project demonstrate that sand fencing and vegetative plantings should be an integral part of sand management of the barrier islands. The project has helped formulate better practices in the establishment of sand fencing and the selection of vegetative species (LDNR, 2006a).

TE-20 Isle Dernieres Restoration – East Island

The objectives of the project were to close existing breaches within the project area, increase the elevation and width of the island, and restore the back barrier marsh. TE-20 involved the construction of temporary perimeter containment dikes using borrow material from Lake Pelto and Whiskey Island Pass to hydraulically fill the dune and marsh templates. The target dune and marsh elevations were +8.0 and +2.0 ft North American Vertical Datum 1988 (NAVD 88), respectively. Approximately 242 acres of dune and wetland habitat were created. The project was completed in October 1998. The restoration efforts on East Island successfully increased the island's elevation and width, yet post-construction storms (Tropical Storm Isidore and Hurricane Lili) reduced the overall volume of the island (LDNR, 2007a).

Additional monitoring of East Island was performed following Hurricanes Gustav and Ike in 2008. Visual observations were made at established stations reaching from the existing shoreline to the back-barrier marsh. The observations indicated that the hurricane events caused a considerable amount of shoreline erosion. Severe overwash was observed on the eastern end, contributing to a loss of approximately 3,000 ft of the newly constructed island template. Due to a lack of established marsh behind the island, the marsh did not properly capture the rollback of the dune (OCPR, 2008b). However, no breaches were observed.

TE-24 Isle Dernieres Restoration – Trinity Island

The objectives of the project were to close existing breaches within the project area, increase the elevation and width of the island, and restore back barrier marshes. TE-24 involved the construction of temporary perimeter containment dikes and using borrow material from Lake Pelto and Whiskey Island Pass to hydraulically fill the dune and marsh templates. The target dune and marsh elevations were +8.0 and +2.0 ft NAVD 88, respectively. Approximately 353 acres of dune and wetland habitat were created. The project was completed in May 1999. Similar to the TE-20 project, the Trinity Island restoration project succeeded its goal of increasing the island elevation and width, yet the post-construction storms reduced the overall volume of the island (LDNR, 2007b).

The monitoring efforts conducted as part of TE-20 (East Island) were also used to assess the impacts of Hurricanes Gustav and Ike on the newly constructed template on Trinity Island. As with East Island, there was a considerable amount of shoreline erosion and overwash caused by the storms. The severe overwash contributed to a loss of 1200 ft of template on the western end of the island. However, no breaches were observed and the island has primarily remained above its pre-construction elevations (OCPR, 2008c).

TE-25 / TE-30 East Timbalier Sediment Restoration – Phases 1 & 2

TE-25 (Phase 1) and TE-30 (Phase 2) were restoration efforts with emphasis on the eastern half and western half of the island, respectively. The restoration included the creation of a 200-ft wide dune, a 600-ft wide back barrier marsh platform, rubble rock revetment, sand fencing, and vegetative planting. The target dune and marsh elevations were +5.0 and +2.0 ft NGVD 29, respectively. The dune was stabilized with a 7,000-ft long rock revetment placed along its gulfward face. Construction was completed in December 1999.

The effective restoration of East Timbalier Island was hampered by poor fill material selection and a design that lacked a fronting beach to protect the dune. These factors may have resulted in the development of several overwash segments along the island. Furthermore, the use of a rock revetment may not be a feasible approach to dune protection because as the island experiences the natural process of "rollover", during which the rocks become disjointed from the shoreline. The disjointed rocks diffract and refract waves in abnormal patterns, thereby disrupting the longshore transport patterns (LDNR, 2005).

TE-27 Whiskey Island Restoration

The objective of the restoration was to close the breach at Coupe Nouvelle and thereby fortify the Gulf shoreline from Coupe Nouvelle to the eastern end of the island. Target elevations of the closure ranged from a maximum of +4 ft to a minimum of +1 ft NAVD 88. Construction was completed in July 1999. The restoration efforts on Whiskey Island achieved its goal of increasing the height and volume of the island. Tropical Storm Isidore and Hurricane Lili reduced the volume of the island but the island did remain intact and provided some protection for the mainland areas (LDNR, 2004).

TE-29 Raccoon Island Breakwaters Demonstration

The objectives of the project were to reduce the rate of shoreline retreat on the eastern end of the island and to protect critical bird nesting habitat. Eight detached and segmented breakwaters were constructed in July 1997 to promote sediment deposition along the beach and upper shore face by decreasing the incident wave energy landward of the breakwaters, and thereby reduce the rate of shoreline retreat. Preliminary data suggest breakwater-induced changes to local wave propagation and attenuation may have resulted in cross-shore sediment trapping and the emergence of sand bodies directly landward of the breakwaters (LDNR, 1999).

TE-37 New Cut Dune and Marsh Restoration

The objective of the restoration was to close the breach between Trinity and East Islands, and thereby increase the structural integrity of eastern Isles Dernieres by restoring the littoral drift and adding sediment in the nearshore system. The breach was closed by hydraulically dredging approximately 850,000 cy of sediment from the borrow area, creating an 8,000-ft dune platform with an elevation matching those of the existing Trinity and East Island elevations. In addition to the sediment fill, 17,000 ft of sand fencing was installed and nine species of native barrier island vegetation were planted on the marsh platform (LDNR, 2007c).

TE-40 Timbalier Island Dune and Marsh Restoration

The objectives of the restoration plan were to restore 2.2 miles of the beach and dune and create a marsh platform through the use of sediment dredged from a nearby borrow area in Little Pass. The constructed dune consisted of a crest width of 400 ft at an elevation of +8.0 ft NAVD 88. Beach fill extended an additional 225 ft from the toe of the berm. The elevation of the beach ranged from +5.0 ft NAVD 88 at the toe of dune to +3.0 ft NAVD 88 on the gulf side. An 800-ft wide marsh platform was constructed at an average elevation of +1.4 ft NAVD 88. Approximately 2,750 linear ft of sand fencing was also installed along the length of the project. Construction was completed in December 2004. (LDNR, 2006b).

Beginning in March 2006, approximately 11,500 ft of sand fencing was added to the restoration project with 2,000 ft of the easternmost fencing being relocated to four alternate locations as a result of the erosion caused by Hurricanes Katrina and Rita (LDNR, 2006c). Operations, maintenance, and monitoring reports have not been published by OCPR.

TE-47 Ship Shoal: Whiskey West Flank Restoration

The project objectives included: 1) restore the integrity of the West Flank of Whiskey Island to retain its structural function; 2) rebuild the natural framework to provide a separation of the Gulf and estuary; 3) create a continuous protective barrier for back bays and inland marshes; and 4) strengthen the longshore transport of sediment for continuous island building through the introduction of new sediment from offshore. To aid in the retention of the restoration fill sediments, sand fencing and vegetative plantings are proposed (USEPA, 2005). Phase I of the CWPPRA process, Engineering and Design, has been completed; however, due to construction funding, Phase II was not immediately recommended and is currently pending.

TE-48 Raccoon Island Shoreline Protection / Marsh Creation

The project was planned as two separate construction phases, Phases A and B. The objective of Phase A was to significantly reduce the wave energy impacting the gulf shoreline through the use of eight segmented breakwaters as a continuation westward of the original eight constructed as part of TE-29. The addition of a terminal groin on the eastern most end of the island extending from the shoreline to the existing breakwater eliminated the tidal currents flowing between the existing breakwaters and the shoreline. Phase A was completed in 2005. The objective of Phase B is to create 60 acres of emergent and intertidal wetlands on the northeast quadrant of the island with hydraulically dredged material. The filled area will be planted with native species based on finished elevations of the subaerial and intertidal areas.

TE-50 Whiskey Island Back Barrier Marsh Creation

The goal of the project is to increase the longevity of the previous TE-27 restoration effort by increasing the island's width. The project consisted of increasing the marsh elevation to at least +2.5 ft NAVD 88. The exiting dune feature was also supplemented to increase the crest width to 100 ft and the height to +6.0 ft NAVD 88. Construction was completed in October 2009. Following construction of the dune feature, sand fencing was constructed parallel to the gulfward face and 30 ft south of the centerline along the length of the newly restored dune. Vegetative planting was conducted in order to stabilize the newly constructed dune and marsh platforms (LDNR, 2009). Operations, maintenance, and monitoring reports have not been published by OCPR.

TE-52 West Belle Pass Barrier Headland Restoration

The goal of this project is to reestablish the West Belle Pass headland by rebuilding a large portion of the beach, dune, and back barrier marsh. Approximately 2 mcy of dredged sand, and 1 mcy of finer material will be used to rebuild nearly 9,300 ft of beach and dune and 150 acres of marsh respectively. Additionally, native vegetation plantings will be used to assist in the stabilization of the rebuilt marsh and dune habitats (LDNR, 2009). TE-52 is currently waiting funding authorization.

TE-53 Enhancement of Barrier Island Vegetation Demonstration

The goal of this demonstration project is to develop cost-effective methods for enhancing vegetative establishment and growth on barrier island restoration projects. Currently, this project is in the planning phase. Two possible project sites have been proposed – site of the Timbalier Island Dune and Restoration project (TE-40), and the New Cut Dune and Marsh Restoration project (TE-37) site (LDNR, 2009b). TE-53 is currently waiting funding authorization.

Evaluation of CWPPRA Projects

While many of the CWPPRA projects implemented throughout the Terrebonne Basin Barrier Shoreline have been effective in reducing coastal erosion, many have not been able to withstand the considerable impacts of the recent hurricanes. One reason for this is that the CWPPRA projects are typically designed for a 20-year duration and are nearing the end of their expected life. The prescribed budgets for CWPPRA projects will not support large-scale island restoration plans that are capable of withstanding major weather events. Therefore, the projects are smaller in scale and typically address a specific deficiency on the island. Furthermore, CWPPRA budgets typically do not support a monitoring plan to evaluate the effectiveness of the projects. However, the projects appeared to have been successful in meeting their project-specific goals of reducing land loss on the islands.

Fortunately, the authorized budget for the LCA TBBSR Study will support a larger restoration effort. During the plan formulation phase of the project, the project delivery team (PDT) was able to capitalize on lessons learned from past CWPPRA projects in order to determine the most cost-effective means of maximizing habitat benefits on the islands. One major lesson learned from the in-situ investigations of the islands and the existing CWPPRA projects was that stand-alone measures were not a viable means of meeting the goals of the project. Therefore, the PDT focused on combinations of measures. By the end of the plan formulation phase, the PDT concluded that each restoration plan must include a beach, dune, and marsh component in order to meet the project goals of restoring the islands geomorphologic form and ecologic function (see Chapter 3). The in-situ investigations also revealed that the project features were not sustainable. Therefore, the PDT assessed the use of renourishment as an O&M activity to increase the longevity of the island plans. Not only is this approach expected to provide more habitat benefits over a longer period of time, it will also bolster existing CWPPRA projects on the islands.

The PDT recognizes the value of a monitoring and adaptive management plan and have thus accounted for the development and execution of a plan in the budget. Monitoring plans provide critical data used to evaluate the effectiveness of a project in meeting goals and objects. This data can be used to assess the validity of the parameters used in the design of the project (i.e. erosion rates, sea level rise rates, etc.) and to optimize the input parameters of future projects. In some situations, real time monitoring data can be used by stakeholders to adaptively manage the project to maintain their effectiveness.

1.5.1.6 Coastal Impact Assistance Program

The Coastal Impact Assistance Program (CIAP) is a grant program authorized by Congress in 2001 to provide assistance to states in mitigating impacts from Outer Continental Shelf (OCS) oil and gas production. The Minerals Management Service (MMS) oversees and administers this grant program. Each oil and gas producing state is allocated their share of funds based on the state's qualified outer continental shelf revenue generated off of its coast in proportion to the total produced by all eligible states.

In 2001, Louisiana received a one-time allocation from the CIAP of $26.4 million, which was used to fund various State and local coastal activities and projects including: monitoring, assessment, research, and planning; habitat, water quality, and wetland restoration; coastline erosion control; and control of invasive non-native plant and animal species (USACE, 2004a). Nominated CIAP projects within the Project area are identified in Figure 1-3 and described in the following sub-sections. Additional information (project location, restoration feature types, cost, benefits, and year of completion) related to these CIAP projects can be found in the general fact sheets and selection criteria documentations provided in Attachment F.

Section 384 of the Energy Policy Act of 2005 authorized an additional $250 million for each of the fiscal years 2007 through 2010 to be distributed to oil and gas producing states. In 2007, Louisiana developed a four year plan to submit grant applications for costal impact projects. Consequently, Louisiana received $127,547,898.57, $120,911,588.83, and $119,663,560.77 in annual allocations in 2008, 2009, and 2010, respectively. The following projects were considered for construction as part of CIAP.

Raccoon Island Breakwaters

This project proposes to increase the number of rock breakwaters from the 16 breakwaters constructed on previous CWPPRA projects (TE-29 and TE-48) to 32. The installation of these breakwaters would provide protection for the western portion of the island and spit (LDNR, 2008a).

Ship Shoal: Whiskey Island West Flank Restoration

The project objectives included: 1) restore the integrity of the West Flank of Whiskey Island to retain its structural function; 2) rebuild the natural framework to provide a separation of the Gulf and estuary; 3) create a continuous protective barrier for back bays and inland marshes; and 4) strengthen the longshore transport of sediment for continuous island building through the introduction of new sediment from offshore. To aid in the retention of the restoration fill sediments, sand fencing and vegetative plantings are proposed (USEPA, 2005).

This project was presented at the CWPPRA PPL 11 (TE-47) planning round. Engineering and design have been completed and Phase II (construction) funding was requested in December 2005, but the project was not selected. This project meets the Coast 2050 strategy of restoring and maintaining barrier islands in addition to meeting the restoration goals identified by the Strategic Plan for Coastal Restoration adopted by the Terrebonne Parish Coastal Zone Management and Restoration Advisory Committee (LDNR, 2008c).

Beach and Back Barrier Marsh Restoration, East and Trinity Islands

The proposed beach and back barrier marsh restoration project on East and Trinity Islands would restore a total of 146 acres of beach and dune habitat and 533 acres of back barrier marsh. This project was presented at the CWPPRA PPL 16 in January 2006, but was not selected for continued investigation.

Wine Island Restoration

This project was nominated by the Louisiana Department of Wildlife and Fisheries (LDWF) and proposes to increase the size of Wine Island and provide for sustainability through the use of hydraulically dredged material from the Houma Navigation Canal. This island provides some protection to the back-bay area and is important to shorebirds (LDNR, 2008d).

East Timbalier Island Restoration

The goal of the project is to reestablish the historic barrier island separating the bay from the gulf, thereby adding protection to interior areas. The proposed project features are the creation of approximately of 3,200 linear feet of segmented breakwaters in the eastern end of the project area by salvaging rocks from the existing rock dikes along the southern boundary of the island; depositing hydraulically dredged sand behind the breakwaters to create approximately 190 acres of supratidal habitat, depositing hydraulically dredging sand to create approximately 180 acres of intertidal habitat on the bay side of the island; vegetative planting on both the dune and marsh habitat; and 8,200 linear feet of sand fencing on the created dune.

The project will benefit the oil and gas facilities operated by Maritech Resources, Inc. These facilities were exposed to the GOM during Hurricane Katrina. Maritech has stated that they would assist in the funding of maintenance after the island is restored (LDNR, 2008f).

East Timbalier Island Sediment Restoration

Hurricanes Katrina and Rita of 2005 further damaged the island, indicating the urgency at which action must be taken. This project plans to build on CWPPRA projects TE-25 and TE-30 by using modern search techniques to find sufficient sediment and sand sources to close a breach in the island and rebuild a larger, wider dune and beach along the island that will be more sustainable. In addition, marsh will be created or maintained where necessary behind the dunes to ensure a uniform width along the length of the island (LDNR, 2008b).

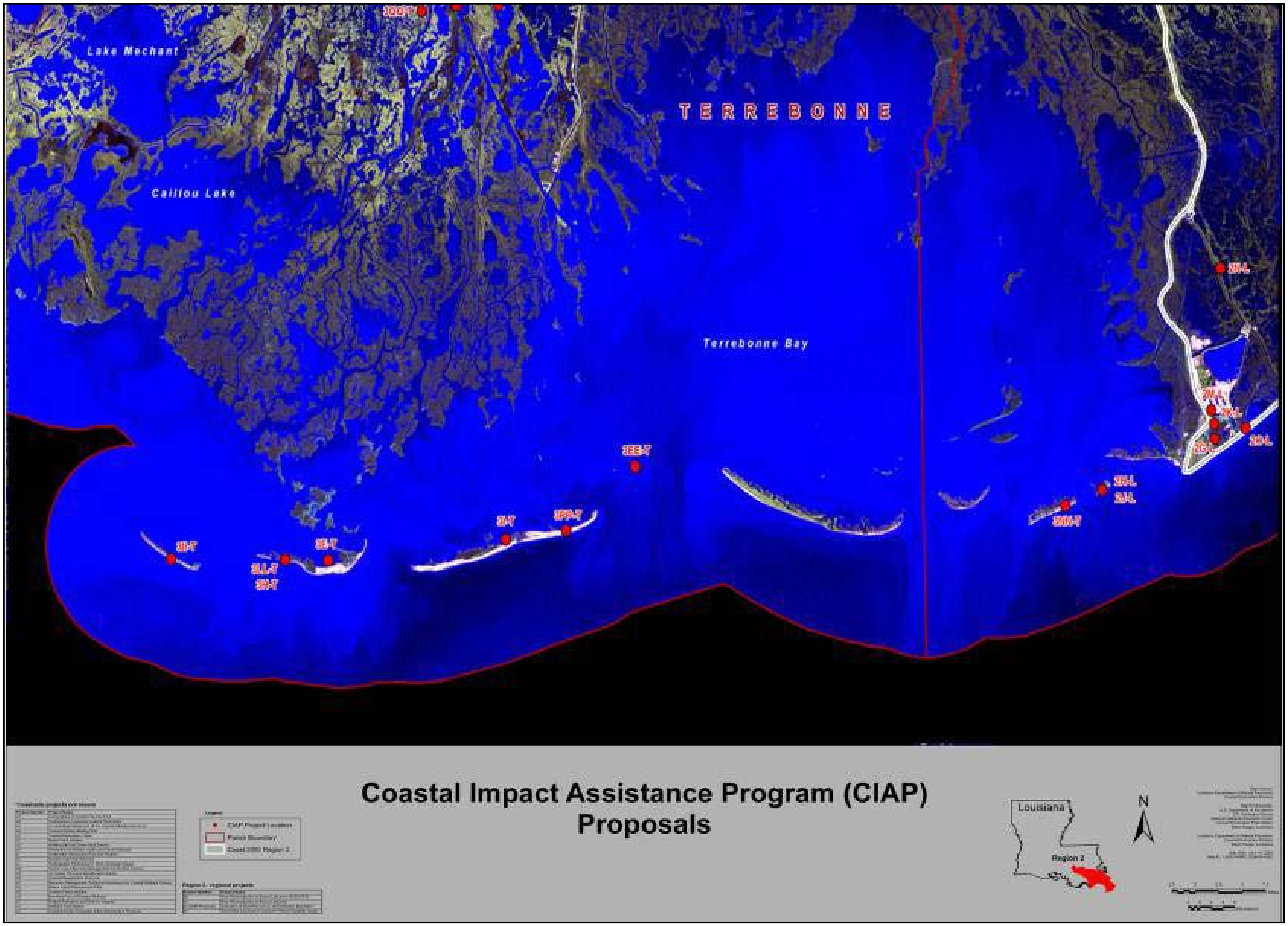

Figure 1-3. Location of Proposed CIAP Projects (LDNR, 2009c)

1.5.1.7 USACE Navigation Projects

There are a number of federally maintained waterways in the vicinity of the LCA TBBSR Study Area. The most important of these in terms of potential direct and indirect impacts on the Terrebonne Basin barrier islands is the Houma Navigation Canal (HNC). This canal, which is approximately 37 miles long, originates in Houma, Louisiana, descends south, and enters the GOM between East Island and Timbalier Island in what is referred to as Cat Island Pass. The HNC currently undergoes maintenance dredging in the inland portions every 8 years; the bay portions every 2 years; and the bar channel section every 2 years. A HNC Deepening Re-evaluation Study is being conducted in response to requests from the Terrebonne Port Commission to deepen the HNC from -18 ft to -20 ft NAVD 88. A preliminary data review revealed that Cat Island Pass and Timbalier Island have stabilized over the last 70 years and that the dredging of an approximate 13 mcy of sediment from a 3.6 mile stretch of the HNC near Timbalier Island would create an imbalance in the littoral system. The natural processes of longshore sediment transport to the west would most likely erode the adjacent barrier island and protective shoals as the channel and island try to reach a quasi-equilibrium state. It is recommended that the sediment dredged from the Pass be placed on the eastern gulf side of the adjacent island such that the placed sediment would supplement the longshore transport. In addition, mixed sediments could be placed on the bay sides of the adjacent islands to promote back-barrier marsh creation. (Lee and Khalil, 2007 and Rosati, 2008). A decision as to which island (Timbalier or East) should receive the fill must await further refinement of the sediment budget for Cat Island Pass and a decision on the final alignment of the HNC through the Pass. At this point there are sound arguments supporting sand placement on either island (Lee and Khalil, 2007 and Rosati, 2008).

1.5.1.8 Beneficial Use of Dredged Material (BUDMAT)

The USACE MVN has the largest annual channel operations and maintenance (O&M) program within the USACE, with an average of 64.0 mcy of material dredged annually. Currently, approximately 24% of the material dredged under USACE's O&M program is used beneficially within the Federal standards. The Federal standard refers to the least costly alternative identified by the USACE that is consistent with sound engineering practices and meets all of the Federal environmental standards established by Section 404 of the Clean Water Act of 1972 and Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. Application of the Federal standard constitutes the base disposal plan for a navigation project. Funds from the BUDMAT Program would be used for disposal activities associated with separate, cost-shared, ecosystem restoration beneficial use projects that are above and beyond the disposal activities that are covered under the USACE O&M maintenance dredging Federal standard.

The BUDMAT study area is Louisiana's coastal area from Mississippi to Texas. Louisiana parishes included in the study area include Ascension, Assumption, Calcasieu, Cameron, Iberia, Jefferson, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Martin, St. Tammany, Tangipahoa, Terrebonne, and Vermilion.

The following nine authorized Federal navigation channels represent the most significant opportunities for additional beneficial use of dredged material in coastal Louisiana:

- Barataria Bay Waterway, LA
- Mississippi River, Outlets at Venice, LA – Tiger Pass and Baptiste Collette
- Mississippi River, Baton Rouge to the Gulf of Mexico, LA – Southwest Pass and South Pass
- Atchafalaya River and Bayous Chene, Boeuf, and Black, LA
- Calcasieu River and Pass, LA
- HNC, LA
- Bayou Lafourche, LA
- Mermentau River, LA
- Freshwater Bayou, LA

Of those listed, two are of major significance to the LCA TBBSR Study. The first is the HNC, a primary navigation route that bisects the project area at approximately 2 miles from both Wine and Timbalier Islands, and serves as a potential source of beneficially used material. The second is Bayou Lafourche, which is at the far eastern periphery of the project area, approximately 3 miles from East Timbalier Island, and also serves as a potential source of beneficially used material.

The 2004 LCA Plan recommended authorization of $100 million in programmatic authority for the additional funding needed for beneficial use of dredged material generated by existing programs. Based on the appropriated funds and a 10-year period of implementation, it is expected that beneficial use of dredged material could attain 21,000 acres of newly created wetlands, which represents a significant opportunity to contribute to the accomplishment of the LCA objectives.

1.5.1.9 Sand Source Studies

In a 1991 report, Suter, *et al.* identified and described many of the previously surveyed and/or utilized nearshore sediment areas in the southeast portion of Coastal Louisiana. Though these potential borrow areas line the immediate gulf-and bay-sides of the Terrebonne Basin barrier islands, only the gulf-side areas are being considered for this study. The State now strongly discourages bayside sediment dredging because of the potential for the borrow areas to adversely affect the barrier islands ability to migrate. Furthermore, borrow areas could potentially serve as sediment sinks in a sediment-starved system.

In April, 2004, the U.S. Department of the Interior, MMS published an Environmental Assessment titled *Issuance of Non-Competitive Leases for the Use of Outer Continental Shelf (OCS) Sand Resources from Ship Shoal, Offshore Central Louisiana for Coastal and Barrier Island Nourishment and Hurricane Levee Construction* (MMS 2004). The assessment analyzed the proposed dredging of approximately 14 mcy of sand for coastal and barrier island restoration and flood levee construction from within two areas: Ship Shoal OCS area Blocks 87, 88, 89, 94, and 95; and South Pelto OCS area Blocks 12, 13, 14, 18, and 19. These blocks are located approximately 10 miles south of the Terrebonne Basin barrier islands.

This report relied on work done in previous investigation, most notably, Stone (2000) and Stone and Xu (1996) to assess direct impacts of sand mining on wave transformation over Ship Shoal. Stone and Xu (1996) conducted a wave modeling analysis to evaluate the effects of large-scale removal of sand from various portions of Ship Shoal. The approach used in the 1996 study centered on the removal of the entire shoal complex using the available bathymetric data for the shoal and surrounding area. The total volume of sand numerically extracted from the shoal for the modeling analysis was over 1.4 billion cy which included up to a 20-ft thick section of sand being removed from the western portion of the shoal. The model runs indicated spatial differences in the magnitude of wave heights across the shoal. The magnitude in wave heights due to shoal removal were less on the east side of the shoal compared to the west side. Wave height changes on the east side of the shoal were reported to be insignificant during severe storms and even less noticeable under fair weather conditions. During severe storm conditions, the model indicated wave breaking does not occur on the east end of the shoal near South Pelto Blocks 12 and 13 because of the greater water depths. The model results did show some increased wave heights in the central and western portions of the shoal but the overall model results indicated that the entire removal of the shoal will not have a significant impact on wave energy conditions along the nearshore zone (MMS 2004).

The report referenced a second field study (Stone 2000) that reported that the shoal plays an important role in mitigating the wave field off Coastal Louisiana but that the model may overpredict wave heights by 6 to 24 percent. The report suggests that removal of large quantities of sand will not significantly influence wave conditions in the nearshore zone because the increase in wave energy is limited to the leeward flank of the shoal (MMS 2004).

Based on the modeling analysis, the MMS Environmental Assessment concluded that dredging 14 million cy of material will have no significant impact on local wave and currents.

In April, 2009, MMS published a second report titled *Environmental Investigation of the Long-Term Use of Ship Shoal Sand Resources for Large Scale Beach and Coastal Restoration in Louisiana Wave Conditions* (Stone et al. 2009). The report was prepared by the Coastal Studies Institute & Department of Oceanography and Coastal Sciences, Louisiana State University (LSU) and the LACES.

This was a collaborative research effort that included a physical oceanography and a biological group (meiofauna group and a macroinfauna/blue crab group). This report looks at the interplay between the physical processes and the benthic biological habitat over Ship Shoal.

The first six chapters of this report focused on geotechnical characteristics, storm-driven sediment dispersion, wave transformation, and lastly, morphodynamic differences between sandy and muddy bottom portions of the shoal. The physical portion of the report culminated with a chapter on the impacts of sand removal on hydrodynamics and sediment transport which is summarized below.

This study utilized state-of-the-art numerical models to investigate the impacts of sand mining on hydrodynamics and sediment transport on Ship Shoal using two case studies. Case study A compared the hydrodynamics of the region under two bathymetric configurations: one with the shoal and the other with the shoal completely removed (i.e. large scale mining scenarios). Case study B utilized four different sand mining scenarios (i.e. small scale mining scenarios) which mimicked proposed restoration project borrow area configurations (Table 1-2). Specifically, they examined wave, current variability, and sediment transport over the shoal under different barrier island restoration/mining scenarios under a winter storm and tropical cyclone event. The researchers looked at mining at three areas of Ship Shoal, namely, South Pelto Blocks 12 and 13, Ship Shoal Blocks 88 and 89, and Ship Shoal Blocks 84, 85, 98, and 99.

Table 1-2. Ship Shoal Mining Scenarios (Stone et al. 2009).

Case	Sand Volume (m^3)	Sand Volume (cy)	Mining Area	Excavation Depth (ft)	Restoration Target
B-1	7,650,000	10,000,000	South Pelto 12/13	0.8	Caminada
B-2	13,760,000	18,000,000	South Pelto 12/13	1.4	Caminada, Whiskey/Trinity
B-3	6,120,000	8,000,000	Ship Shoal 88/89	0.7	Whiskey/Trinity
B-4	9,180,000	12,000,000	Ship Shoal 88/89	1.0	Entire Isles Dernieres
B-5	9,180,000	12,000,000	Ship Shoal 84/85, 98/99	1.2	Entire Isles Dernieres

Large-scale Mining Scenario

The modeling results indicated that Ship Shoal has significant influence on wave dissipation but suggests that neither large-scale nor small-scale sand mining should result in abrupt changes in current patterns. The results indicated that large-scale sand dredging will have spatially profound impacts on waves as shown on Figure 1-4 as well as on sediment suspension. Wave height attenuation of 22% was computed for waves crossing over the shoal from the south which indicates the effectiveness of the shoal in shielding the coast from storm events. Furthermore, changes in wave transformation and sediment suspension suggest that large-scale sand mining will enhance fluid mud accumulation on the shoal which would adversely affect the associated benthic community. Based on this analysis, large scale mining of Ship Shoal was not recommended. However, it should be noted that this model looked at the extreme worst-case scenario of complete removal of the shoal. This scenario is not realistic due to the required setbacks associated with oil and gas infrastructure located on the shoal.

Small-scale Mining Scenario

The results indicated that small-scale sand mining based on the sand mining scenarios presented in Table 1-3 is not expected to profoundly impact hydrodynamics and sediment transport over the shoal. The model showed that waves were higher without the shoal than with the shoal. The small-scale scenarios, which removed between 7.68 and 13.76 mcy of sand, had only minor effects on wave heights.

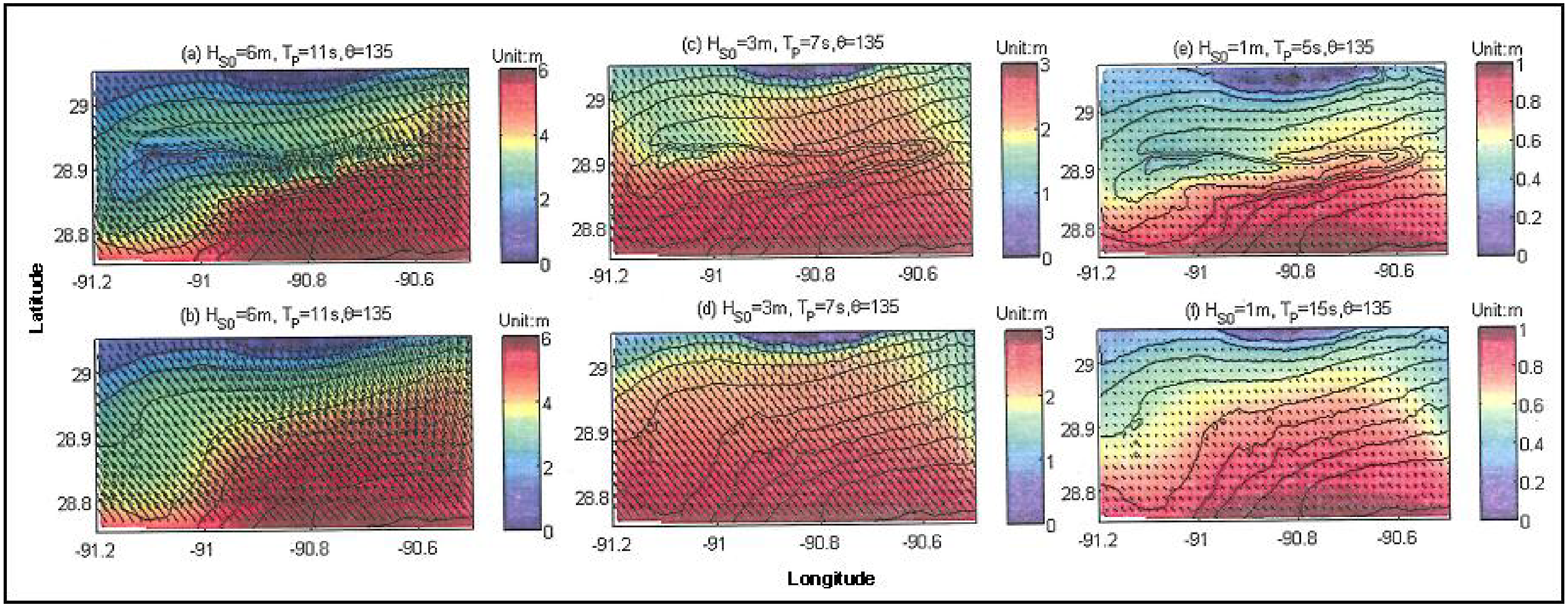

Figure 1-4. Wave height and vector distributions for case Study A: (a, b) H_S=6m, T_P =11s, Wave direction=135 (degree). (c,d) H_S=3m, T_P =7s, Wave direction=135 (degree), (e,f) H_S=1m, T_P =5s, Wave direction=135 (degree). Top figures represent the results with the shoal and bottom figures represent the result without the shoal (Stone et al. 2009).

The results indicated that small-scale sand mining based on the sand mining scenarios presented in Table 1-3, is not expected to profoundly impact hydrodynamics and sediment transport over the shoal.

Table 1-3. Maximal difference in magnitude of hydrodynamic parameters between actual bathymetry and hypothetical bathymetry. Top low; Maximal difference in absolute magnitude of each parameter. Bottom low: Maximal values in magnitude of each parameter during model duration (Stone et al. 2009).

Storm	Case	Wave height	Surface currents (m/sec)	Bottom currents (m/sec)	RI N m-2
Winter storms	B2	0.09 1.19	0.17 0.59	0.03 0.20	0.02 0.82
	B4	0.04 1.30	0.11 0.49	0.06 0.15	0.02 0.62
	B5	0.03 1.67	0.16 0.10	0.06 0.10	0.02 0.60
Hurricane Lili	B2	0.07 1.52	0.09 0.97	0.04 0.33	0.01 1.10
	B4	0.04 2.06	0.15 0.75	0.07 0.22	0.08 1.16
	B5	0.07 3.47	0.05 0.06	0.03 0.15	0.04 1.39

The ecological investigation addressed the following questions:

- What is the abundance, taxonomic composition and community structure of Ship Shoal's meiofaunal community?
- What is the abundance, taxonomic composition and community structure of Ship Shoal's macrofaunal community?
- How are Ship Shoal's meio/macrofaunal communities affected by hysical parameters (e.g. substrate composition, water depth, currents, position on the shoal), and water chemistry?
- What is the relationship between the dominant members of Ship Shoal's benthic communities and the gut contents/fullness of its white and brown shrimp?
- What are the potential impacts of sand mining on the taxonomic composition and community structure of Ship Shoal communities? Specifically, how rapidly will these communities recover and how will the taxonomic composition of the recolonized areas compare with pre-impact conditions?

Benthic Meiofaunal Community

Relatively few studies of the meiofaunal of shallow continental shelf in the northern Gulf of Mexico have been performed and no previous research has been conducted on the meiofaunal of sandy shallow subtidal sediments in Louisiana. Life history characteristics of interstitial fauna differ from burrowing species in that brooding is more common and reproductive rates are lower (Swedmark 1964). Meiofauna appear to be less sensitive to physical disturbance (Schratzberger and Warwick 1998) but are generally slower to recolonize sediment after disturbance events (Colangelo et al. 1996 compared to burrowing meiofauna (Chandler and Fleeger 1983).

- Findings suggest that Ship Shoal meiofauna are interstitial compared to the burrowing meiofaunal of surrounding sediments off the shoal
- Evidence that major taxon and species composition differs substantially from surrounding muddy bottoms
- Lower densities on Ship Shoal than surrounding Louisiana continental shelf. Lower abundances in sandy sediments is commonly reported.
- Meiofaunal abundance was not correlated with specific physical/chemical conditions on Ship Shoal.
- Interstitial meiofauna appear to be more resilient than burrowing fauna to physical disturbance (Schratzberger and Warwick 1998).
- Meiofauna densities are typically highest in the upper 4-6 cm of sediment.
- Meiofauna appear to be more resilient to sublethal physical disturbance because they are adapted to disturbance caused by weather
- Meiofauna lack dispersing largal stages but re-colonize through the overlying water which facilitates rapid recovery of areas affected by small-scale disturbances (Chandler and Fleeger 1983).
- Larger areas of disturbance may be more rapidly colonized by macrofauna larvae because they are adapted to long-distance dispersal.
- Other studies suggest a slow rate of recovery for meiofauna following sand mining (Vanaverbeke et al. 2002; Vanaverbeke and Vincx 2008).
- Other studies suggest that macrofaunal recover following sand disturbance may take many months to years (Palmer et al. 2008).

Benthic Primary Production (BPP)

- Concluded that benthic micro-algae (BMA) likely serves as the foundation for unique ecological services provided by Ship Shoal
- High oxygen content on Ship Shoal when surrounding waters were hypoxic or near hypoxic
- BMA may periodically exceed phytoplankton biomass found in the water-column
- Therefore, BMA rather than phytoplankton, may contribute the most energy flow through the local Ship Shoal food web.

Benthic Macrofaunal Community

- Results suggest that Ship Shoal represents a faunally distinct habitat type in transition between in-shore and offshore habitats.
- Species composition on Ship Shoal differed between east and west as well as north and south areas.
- Species composition was similar to communities associates with Mississippi and northwest Florida seashore.
- Overall species richness of macrobenthos totaled 118 species. Benthic assemblages in other nearby areas affected by hypoxia were reported to have mean species richness of 19 during the same period.
- Dissolved oxygen concentrations on the shoal were relatively high compared to surrounding areas prone to hypoxia.
- Newell et al. (1998) estimated the rate of recovery for sandy sand environments after dredging or mining activities is 2 to 3 years or longer depending on the proportion of sand removed, the proportion of slow-growing species and intensity of the disturbance.
- The community on Ship Shoal is equilibrated and species rich which suggest that biological interactions rather than changes in environmental parameters control the community composition.
- Many species found on Ship Shoal are "equilibrium species" (K-strategists) (Newell et al. 1998), indicated by their relatively large body size, slow reproduction rate and long life-cycles. These species are considered sensitive species (Gesteira and Dauvin 2000) and will probably be strongly affected by long-term sand mining.
- A shift in dominance to small, rapid-growing species will reduce the community biomass which may result in indirect effects at higher trophic levels.

Commercially-Important Species

- Overall catch of brown shrimp, white shrimp and croaker was very low.
- Effects of sand mining are expected to have less effect on nekton that infauna because nekton are highly mobile and can avoid the dredging operation.
- Found that Ship Shoal is a nationally important blue crab spawning/hatching/foraging ground.

Ship Shoal possesses a unique benthic meiofaunal and macrofaunal community due to its sandy substrate and water depths. Their findings suggest that Ship Shoal may also provide a refuge from seasonal hypoxia because dissolved oxygen concentrations over the shoal remained high throughout the spring, summer, and autumn sampling periods. The overall species richness of macrobenthos on the shoal totaled 118 species. Baustian (2005) reported much lower species richness (19 species) over a much broader area off coastal Louisiana affected by hypoxia. Benthic micro-algae, as opposed to phytoplankton, may be the dominant contributor to primary production on the shoal.

1.5.1.10 USACE Continuing Authorities Program, 1996

Section 204 of WRDA 1992, as amended in WRDA 2007 Section 2037, is a "continuing authority" that authorizes the Secretary of the Army to plan, design, and implement certain ecosystem restoration measures, subject to specified cost sharing, cooperation, and positive Secretarial findings, without additional project-specific Congressional authorization. Section 204, as amended, authorizes the beneficial use of sediments in connection with construction, operation, or maintenance dredging of an authorized Federal water resources project. Section 2037 of WRDA 2007 amends WRDA Section 204 cost sharing responsibilities for beneficial use of sediment for the protection, restoration, and creation of aquatic habitats from 75% Federal and 25% non-Federal to 65% Federal and 35% non-Federal.

Section 206 of WRDA 1992 is a “continuing authority” that authorizes the Secretary to construct projects for the restoration and protection of aquatic ecosystems without any “connection” to an existing Corps project. This authority is directly related to the restoration of the Terrebonne Basin Barrier Island Chain.

Section 1135 of WRDA 1992 is a “continuing authority” that authorizes the Secretary to restore habitat and improve water quality that has been impacted by existing Corps projects (navigation structures, locks and dams, reservoirs, etc). Non-governmental, non-profit groups may also sponsor projects under this authority. This authority could be utilized to modify dredging operations of the Houma Navigation Canal to benefit the project, if the canal proves to be a viable source of sediment for use in the restoration efforts.

In addition to coastal restoration efforts undertaken through the efforts discussed above, other Federal and State coastal restoration efforts over the years have resulted in the construction of State projects, Federal projects, and State vegetative plantings (LDNR, 2003). One of the more significant contributions to the restoration of coastal wetlands has been a result of the North American Wetlands Conservation Act, administered by the USFWS. The 1999 and 2001 biennial North American Wetlands Conservation Act report presented to Congress cites 30,558 acres of restoration and 40,348 acres where ecosystem function has been improved in coastal Louisiana wetlands.

1.5.1.11 Second Emergency Supplemental Appropriations Act to Meet the Immediate Needs Arising from the Consequences of Hurricane Katrina, 2005 (Public Law 109-062)

The Second Emergency Supplemental Appropriations Act to Meet the Immediate Needs Arising from the Consequences of Hurricane Katrina, 2005 (Public Law 109-062) was adopted by Congress on September 2, 2005. This law provided emergency supplemental funding to repair damage to flood risk management and hurricane shore protection projects.

1.5.1.12 Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006 (Public Law 109-148)

The "Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006" (Public Law 109-148), provided funds for the LACPR efforts.

1.5.2 State

1.5.2.1 Louisiana's Comprehensive Master Plan for a Sustainable Coast, 2010

The Louisiana Legislature, through Act 8 of the First Extraordinary Session of the 2005 Louisiana Legislature, established the Coastal Protection and Restoration Authority (CPRA) to develop, implement, make reports on, and provide oversight for a comprehensive coastal protection master plan and annual coastal protection plans. Several measures proposed in the Master Plan were incorporated into the initial array for this LCA TBBSR Study.

1.5.2.2 Gap Analysis

In July 2008, the PDT conducted a gap analysis to determine whether adequate data and information were available for the Timbalier and Isles Dernieres Barrier Island reaches to proceed with the Feasibility Report. This gap analysis addressed the availability of data for hydrology, geology, topographic and bathymetric surveys, coastal processes, environmental resources and habitats, threatened and endangered species, magnetometer and cultural resource surveys, oil and gas infrastructure, land and water resources, economic resources, project designs, land use, and navigation.

Because of the emphasis historically placed on barrier island research and barrier island restoration, a rich body of data and literature exist to support the Terrebonne Basin Barrier Shoreline Restoration Project. This data came in the form of planning documents, such as the Louisiana Coastal Area (LCA), Louisiana Ecosystem Restoration Study, engineering reports, survey reports, Environmental Assessments, Final Programmatic Environmental Impact Statement (FPEIS) reports, geological/geotechnical reports and ongoing monitoring programs.

The first large-scale dune building and stabilization project in Louisiana that used sand fences to stimulate accretion was constructed at Timbalier Island in 1979 and 1980 by Texaco USA. Five years later the Terrebonne Parish Barrier Island Restoration Project was built at the eastern end of the Isles Dernieres. In 1988 a preliminary coastal engineering report for the Isles Dernieres Barrier Island Stabilization Project and an Environmental Assessment was prepared before the program was terminated by the State. Since the enactment of the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) in 1990, eleven barrier island restoration projects have been constructed and four have been authorized for construction.

As part of the engineering and design of these projects, bathymetric and topographic surveys, hazard and magnetometer surveys, cultural resources assessments, sand source surveys, and wetland value assessments are typically conducted. Environmental Assessments are also required before any specific project can be funded for detailed plans and specifications, and construction. Because of the rich history of coastal restoration efforts and applied research within the Study Area, there is an abundance of project-specific data.

In addition to the project specific data, the LCA Science and Technology Program has developed the Barrier Island Comprehensive Monitoring Program (BICM) that is providing long-term data on Louisiana's barrier islands which will allow for the evaluation of constructed projects as well as for planning and design of future barrier island projects. Important components monitored by BICM include bathymetry, topography, shoreline change, habitats, and storm assessment protocol.

After conducting a thorough review of all relevant project data and information, and performing the pertinent analyses, the PDT determined that there was sufficient information available to proceed with the Feasibility Report. Further, it was determined that no additional data collection or analysis is necessary at this time to complete the Feasibility Report.

Specifically, the PDT determined that there are sufficient hydrologic data; topographic, bathymetric, geophysical, geotechnical, and magnetometer survey data; coastal processes forcing functions; threatened and endangered species, wildlife, natural resources, and cultural resources information; and historical information to complete the Plan Formulation and Alternatives Analyses tasks. Ship Shoal has been identified as the primary borrow area and it contains sufficient quantities of beach compatible sand for the Study Area.

1.6 Planning Process and Report Organization

The Terrebonne Basin Barrier Shoreline Restoration project follows the USACE six-step planning process specified in Engineering Regulation (ER) 1105-2-100. The planning process identifies and responds to problems and opportunities associated with the Federal objective and specified State and local concerns. This integrated report includes elements of both the planning process and sections specific to the NEPA review of the project.

The chapter headings and order in this report generally follow the outline of the required NEPA documentation for an EIS. Chapters of the report relate to the six steps of the planning process in ER 1105-2-100 as follows:

- Chapter 2: Need For and Objectives of Action
  This chapter addresses the first step in the planning process. In the first step of the planning process, the Study Area problems and opportunities are defined in addition to the constraints, goals, and objectives. An initial statement of problems and opportunities was developed for the 2004 LCA report which reflected the priorities and preferences of the Federal government, non-Federal sponsor, and other stakeholders. This report presents an updated problem identification that includes enhanced understanding of the process and problems of the Study Area.

- Chapter 3: Alternatives
  The third chapter of this report addresses the third, fifth, and sixth steps in the planning process. Step three of the planning process is the formulation of alternative plans. During this step, the plans developed in the 2004 LCA report were reevaluated. The fifth step in the planning process addresses comparisons of the alternative plans with emphasis on the outputs and affects each alternative. During the sixth step of the planning process, the selection of the recommended plan is made based upon the comparison of the alternative plans.

- Chapter 4: Affected Environment

The fourth chapter of this report addresses the second step of the planning process which requires an inventory and forecast of resources within the Study Area. The inventory and forecast of the Study Area provides the without project condition and is the basis of comparison for the alternatives.

- Chapter 5: Environmental Consequences
  The fifth chapter of this report covers the fourth step of the planning process which evaluates the effects of the proposed alternative plans in terms of ecosystem benefits. The evaluation criteria are based on the overall goals and objectives of the LCA program and specific planning objectives and purposes of the near-term critical restoration projects recommended in the 2005 Chief of Engineers Report.

1.7 USACE Campaign Plan

The USACE has developed a Campaign Plan with a mission to "provide vital public engineering services in peace and war to strengthen our Nation's security, energize the economy and reduce risk from disasters." This Campaign plan is shaping USACE command priorities, focusing transformation initiatives, measuring and guiding progress, and helping the USACE adapt to the needs of the future.

USACE Campaign Plan Goals and Objectives Summary

- Goal 1: Deliver USACE support to combat, stability and disaster operations through forward deployed and reach back capabilities.
  - Objective 1a: USACE is ready, responsive and reliable in delivering high performance, all hazard, and contingency mission execution in a world-wide theater of operations.
  - Objective 1b: Prepare Theater Engineer Commands (TEC) to support Combatant Commanders throughout the spectrum of operations.
  - Objective 1c: Establish human resources and family support programs that promote readiness and quality of life.
  - Objective 1d: Institutionalize USACE capabilities in interagency policy and doctrine.

- Goal 2: Deliver enduring and essential water resource solutions through collaboration with partners and stakeholders.
  - Objective 2a: Deliver integrated, sustainable, water resources solutions.
  - Objective 2b: Implement collaborative approaches to effectively solve water resource problems.
  - Objective 2c: Implement Streamlined and Transparent Regulatory Processes to Sustain Aquatic Resources.
  - Objective 2d: Enable Gulf Coast recovery.

- Goal 3: Deliver innovative, resilient, sustainable solutions to the Armed Forces and the Nation.
  - Objective 3a: Deliver sustainable infrastructure via consistent and effective military construction and real estate support to customers.
  - Objective 3b: Improve resilience and lifecycle investment in critical infrastructure.
  - Objective 3c: Deliver reliable infrastructure using a risk-informed asset management strategy.
  - Objective 3d: Develop and apply innovative approaches to delivering quality infrastructure.

- Goal 4: Build and cultivate a competent, disciplined, and resilient team equipped to deliver high quality solutions.
  - Objective 4a: Identify, develop, maintain, and strengthen technical competencies in selected Communities of Practice (CoP).
  - Objective 4b: Communicate strategically and transparently.
  - Objective 4c: Standardize business processes.
  - Objective 4d: Establish tools and systems to get the right people in the right jobs, then develop and retain this highly skilled workforce.

This project addresses two points of the USACE Campaign Plan. The second goal of the USACE Campaign Plan is addressed by this project since it is an element of the LCA ecosystem restoration plan on the Gulf Coast. This project also addresses the third goal through the application of the planning process to formulate, analyze, and evaluate alternative designs in pursuit of a sustainable, environmentally beneficial, and cost-effective ecosystem restoration design.

2.0 NEED FOR AND OBJECTIVES OF ACTION

2.1 NATIONAL OBJECTIVES

The USACE planning process is based on the economic and environmental Principals and Guidelines (P&G) promulgated in 1983. The P&G provide for development of reasonable plans that are responsive to National, State, and local concerns. Planning project benefits are quantified in this process as National Economic Development (NED) output, National Ecosystem Restoration (NER) output, or a combination of NED/NER output.

Ecosystem restoration is one of the primary goals of the USACE Civil Works Program. The USACE objective in ecosystem restoration planning is to contribute to NER. NER contributions include increases in the net quantity and/or quality of desired ecosystem resources. NER measurements are changes in ecological resource quality as a function of improvement in habitat quality and/or quantity. The units are expressed quantitatively in physical units or indexes that are not based on monetary units. Net changes are measured in the Study Area and in the rest of the Nation. Single-purpose ecosystem restoration plans shall be formulated and evaluated in terms of their net contributions to increases in NER output. Multipurpose plans that include ecosystem restoration shall contribute to both NED outputs and NER outputs. For multipurpose projects, a plan that trades off NED and NER benefits to maximize the sum of net contributions to NED and NER is usually recommended. However, under Title VII of WRDA 2007, any project or separable project element under LCA may be justified by the environmental benefits alone and economic justification is not required if the Secretary determines that the project or activity is cost-effective.

Louisiana contains one of the largest expanses of coastal wetlands in the contiguous United States and accounts for 90 percent of the total coastal marsh loss occurring in the Nation. The LCA TBBSR Study Area is an essential ecosystem since it includes wetland habitats, essential fish habitat, and has high fish and wildlife values. The barrier islands protect the interior coastal wetlands, which also have high fish and wildlife value as well as great economic value as commercial and recreational fisheries. These ecosystems provide habitat for migratory birds, wildlife, finfish, shellfish, and other aquatic organisms including threatened or endangered species. The restoration of these barrier islands would protect these national assets from further degradation.

2.2 PUBLIC CONCERNS

Public input was received during several scoping meetings as well as meetings with various stakeholders. Many people expressed that the timeline for the Study needed to be advanced due to the urgency of the need in the Study Area. Others worried about access to and protection of the restored areas. The impact on landowners and users of the Study Areas was discussed as well as the impact on threatened and endangered species. Comments were received concerning construction methods and borrow sources. Effects to the tidal prism were also mentioned.

Details of the public comments about the Study are in Chapter 6 of this document.

2.3 Problems, Needs, and Opportunities

2.3.1 General Problem Statement

The overarching problem in the Study Area is a lack of sustainability of the coastal ecosystem, primarily due to coastal land loss. Natural processes and human actions, such as the construction of oil field canals and the containment of waterways, have threatened the long-term viability of the Study Area. These processes and activities have all caused significant adverse impacts to the Terrebonne Basin barrier island shoreline, resulting in extensive barrier island habitat loss and ecosystem degradation. (USACE, 2004a).

Specific problems in the LCA TBBSR Study Area are:

- Land loss due to erosion threatens the geomorphic and hydrologic barrier systems
- Longshore sediments are significantly reduced, limiting the ecosystem's ability to be self-sustaining.
- Loss of barrier island/headland ecosystem habitat
- Freshwater wetlands are impacted by increased salinity

The following sections discuss general ecosystem problems identified in the Study Area.

2.3.2 Subsidence

Land elevations decrease due to subsidence from compaction and consolidation of sediments, faulting, groundwater depletion, and sub-surface fluid extraction. Land elevations increase due to sediment accretion from riverine and littoral sources and organic deposition from vegetation. Vertical accretion in the majority of the Study Area is insufficient to offset subsidence, decreasing land elevations. Based on NOAA's (http://tidesandcurrents.noaa.gov) current mean sea level (MSL) trend at Grand Isle, LA of 9.24 mm/yr and global MSL rise of 1.7 mm/yr (USACE, 2009b), the subsidence rate in the LCA TBBSR Study Area is estimated at 7.54 mm/yr.

2.3.2.1 Sea Level Change

2.3.2.1.1 Eustatic Sea Level Change

Eustatic sea level change is the global change of the oceanic water level. According to the Intergovernmental Panel on Climate Change (IPCC, 2007), the global mean sea level (MSL) rose at an average rate of about 1.7 mm/yr during the twentieth century. Recent climate research has documented global warming during the twentieth century, and has predicted either continued or accelerated global warming for the twenty-first century and possibly beyond (IPCC, 2007). There are numerous projections of future eustatic sea level rates (NRC, 1987). The NRC recommends that three eustatic sea level accelerations be evaluated for engineering projects, namely NRC curves I, II, and III. The latest Corps guidance (USACE, 2009b) recommends the use of NRC curves I and III for projecting the intermediate and high eustatic sea level rates (Figure 2-1). The corresponding eustatic sea level changes between 2006 and 2062 are estimated at 222 mm for the intermediate rate and 635 mm for the high rate.

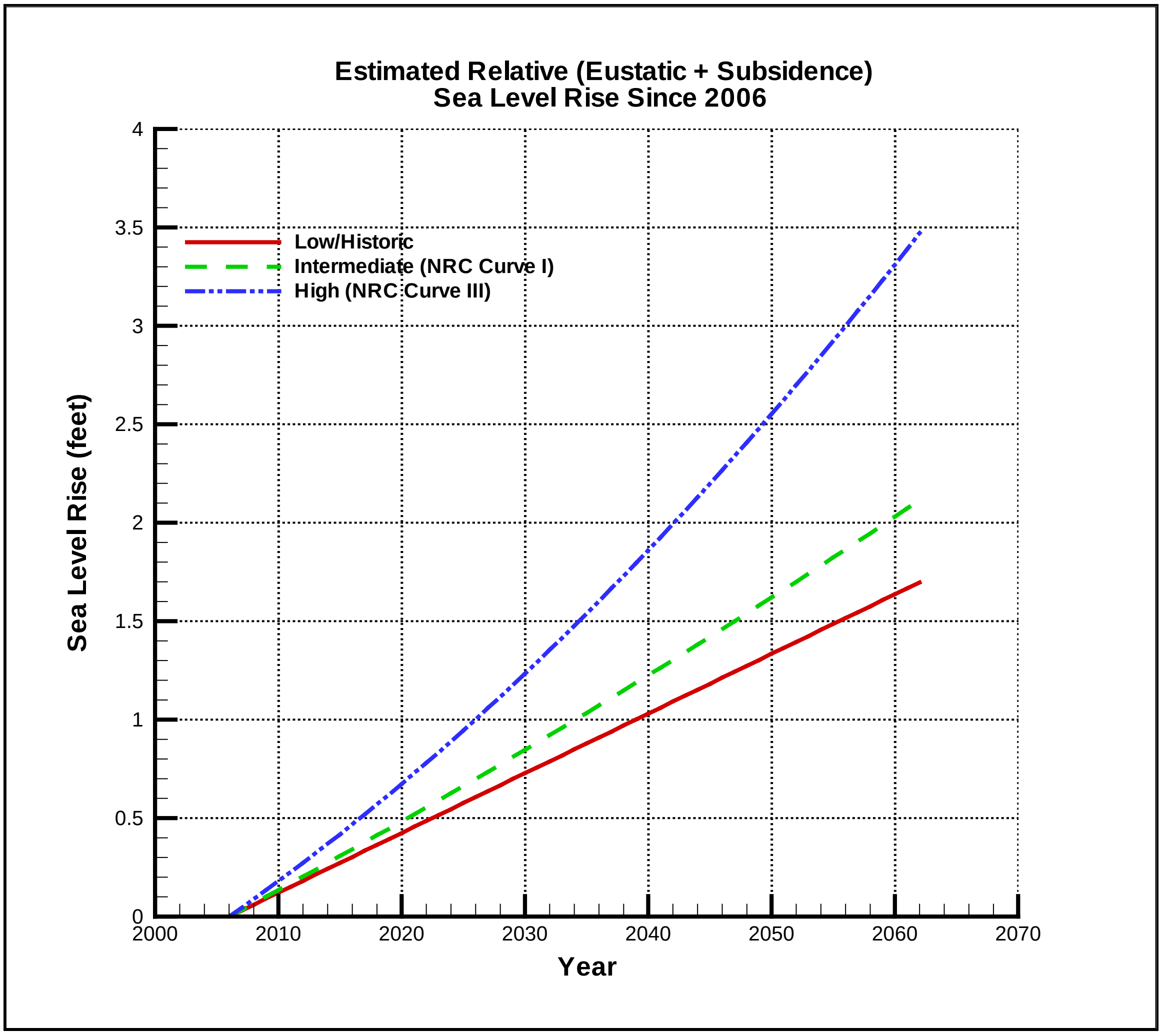

Figure 2-1: Estimated Relative Sea Level Rise since 2006

2.3.2.1.2 Relative Sea Level Change

Relative sea level change is the term applied to the effects of the combination of eustatic sea level change and the change in land elevation. The combination of subsidence and eustatic sea level rise is likely to cause the landward movement of marine conditions into estuaries, coastal wetlands, and fringing uplands (Day and Templet, 1989; Reid and Trexler, 1992).

According to NOAA (http://tidesandcurrents.noaa.gov), the relative mean sea level trend at Grand Isle, LA is 9.24 mm/yr with a 95% confidence interval of +/- 0.59 mm/yr. Using the USACE (2009b) projections of future changes in mean sea level, the estimated relative sea level changes in the LCA TBBSR Study Area between 2006 and 2062 are 517 mm, 644 mm, and 1058 mm, for the low/historic, intermediate and high rates, respectively.

2.3.2.1.3 Retreating and Eroding Barrier Islands

The barrier islands in the Study Area are the remains of an abandoned Mississippi River Delta; and their degradation is the result of the anthropogenic activities and natural deltaic processes. Barrier islands act as a buffer to reduce the effects of ocean waves and currents on associated estuaries and wetlands. Louisiana's barrier islands are eroding at a rate of up to 20 meters per year, and according to recent United States Geological Survey (USGS) estimates, several of these islands will disappear by the end of the century (LACPR, 2009). The disappearance of the barrier islands exposes coastal wetlands to the full force and effects of wave action, saltwater intrusion, storm surge, and tidal currents, accelerating wetlands deterioration.

2.3.2.1.4 Lack of Sediment

As discussed in the previous section, the barrier islands in the Study Area are the remnants of the abandoned Mississippi River Delta. The islands currently exist in a sediment-starved environment typical of the erosional barrier arc stage of the deltaic cycle. The lack of sediment is also attributed to the islands being cut off from potential sediment sources by the Mississippi River by flood protection levees and other navigation projects such as the Belle Pass jetties to the east of the Study Area.

2.3.2.1.5 Shoreline Erosion

The soil along natural ridges and barrier islands is susceptible to wind-induced erosion. Storm events can directly and indirectly contribute to coastal land loss through a variety of ways: erosion from increased wave energies, removal and/or scouring of vegetation from storm surges, and saltwater intrusion into estuaries and interior wetlands carried by storm surges. These destructive processes can result in the loss and degradation of large areas of coastal habitats in a relatively short period of time (days and weeks versus years). When these soils are eroded away, organic marsh soils are directly exposed to open water wave attack. Tropical storm events and natural tidal processes are other natural causes of shoreline erosion. Combining these natural causes with man-made activities (navigation/access channels) further subjects inland areas to more dramatic tidal forces and wave action, increasing erosion.

2.3.2.1.6 Modification of Natural Hydrology

Navigation channels, control of the Mississippi River and its distributaries, and canals dredged for oil and gas extraction have dramatically altered the hydrology of the Study Area. By altering salinity gradients and patterns of water and sediment flow through marshes, canal dredging not only directly changed land to open water, but also indirectly changed the hydrological processes essential to a healthy coastal ecosystem.

Man-made canals and channels have also affected natural hydrology, affecting the sediment and nutrient transport along the islands. Dredged material banks also block the movement of sediment re-suspended during storms, which plays a major role in sustaining land elevations (Reed et al., 1997). Back barrier canals also act as sediment sinks, hindering the natural overwash and migration process of the islands.

2.3.2.1.7 Saltwater Intrusion

Saltwater intrusion changes the salinity gradient, which results in habitat changes. Salinity levels exist along a gradient, which declines as the saltwater moves inland from the GOM. A distinct zonation of plant communities, or vegetative habitat types, differing in salinity tolerance exists along that gradient, with the species diversity of those zones increasing from salt to fresh environments. Changes to the salinity gradient are caused by a number of factors, including: the construction of levees, man-made channels and canals, and degraded barrier islands. Tropical storm events can introduce saltwater into fresher areas, damaging large amounts of habitat in a short period of time.

2.3.2.2 Habitat Changes and Land Loss

2.3.2.2.1 Wetland Loss

Perhaps the most serious and complex problem in the Study Area is the rate of land and habitat loss. As noted above, relative sea rise, tropical storms, shoreline erosion, modification of natural hydrology, and other factors contribute to loss of the barrier islands in the Study Area. The sustainability of the coastal ecosystems is threatened by the inability of the barrier islands to maintain geomorphologic functionality.

2.3.2.2.2 Herbivory

Both the native muskrat (*Ondatra zibethicus*) and the introduced nutria (*Myocastor coypus*, native to South America) are major contributors to wetland losses in coastal Louisiana (LACPR, 2009). The nutria have experienced a rapid expansion of their population since their introduction into the Louisiana coastal wetlands in the 1930s. The grazing and foraging for plant roots by both species have led to "eat-outs", which often result in significant local impacts to area marshes. Although these eat-outs may recover under some conditions, tropical storm impacts on an eat-out area may directly convert these marshes to permanent open water conditions (USGS, 2000). Often, the resulting landscape is dominated by aggressive non-native and/or unpalatable native plants, and a weakening of the marsh structural integrity (Baroch, et al., 2002).

2.3.3 Needs

Critical needs in the Study Area include:

- Restore and/or preserve critical and essential geomorphic structures (beach, dune, ridge, and marsh) of the Terrebonne Basin barrier system.
- Reduce and/or prevent future land loss, habitat loss, and fragmentation of the land features.
- Protect vital local, regional, and national socio-economic resources.
- Protect the back barrier estuarine environments from the high energy marine processes and associated salinities of the Gulf of Mexico.
- Near-term restoration should be synergistic with future restoration by maintaining or restoring the integrity of Louisiana's coastline, upon which all future coastal restoration is dependent.
- Design and operate restoration features that support the development of large-scale, long-range comprehensive coastal restoration.

The natural processes of subsidence and erosion have combined with human-caused effects leading to significant shoreline retreat and land loss along the Terrebonne Basin barrier island chain. Construction of levees along the Mississippi River to prevent flooding has effectively stopped the nourishment of the wetlands with riverine nutrients and sediments. Confinement of the Mississippi has also caused its bedload to be deposited in progressively deeper waters of the GOM. In addition, the sediment load of the river has declined by over 50% due to flood control works and bank stabilization upstream. The latter two factors have prevented the Mississippi River sediments from nourishing the barrier islands (USACE, 2004a).

The Isles Dernieres and Timbalier barrier islands are expected to be impacted by multiple tropical weather events over the next several decades. Each storm poses the risk of breaching the existing islands. As a result, these barrier islands will continue to degrade and migrate landward as an increasingly fragmented chain of smaller barrier islands. The fragmentation of the barrier islands will progressively increase the risk of a single storm event causing widespread fundamental changes in the hydrodynamics and ecological function of the interior bay system. Based on historical trends, a direct hurricane or tropical storm impact can be expected on a frequent basis.

Complete opening of the bays to the unabated effects of storms will increase the volume of open water and fetch within these bays, decreasing their ecologic value. Ecologic changes will occur and storm surges will increase, requiring greater levels of flood risk reduction infrastructure in populated areas. As the islands continue to fragment and migrate northward allowing intrusion of the GOM, restoration will become progressively more expensive and difficult to implement. The effects of increased wave and storm energy will increase stress on, and contribute to a reduction in the vigor and aerial extent of, the remaining wetlands that now serve as a buffer affording protection against storms to the developed areas located north of the Study Area (USACE, 2008).

2.3.4 Study Area Opportunities

To address the overarching Study Area problem of sustainability, a combination of restoration strategies applied in a systematic manner to restore the ecosystem is needed. Examples of restoration strategies are vegetative planting, the use of dredged material for site-specific restoration (beach and marsh fill), hydrologic modification, restoration/preservation of critical geomorphic structures, and where appropriate hard-structural solutions (breakwaters, revetments, etc.). These and other restoration strategies are represented by the various management measures evaluated.

Opportunities for ecosystem restoration include:

- Increase longevity of the barrier island geomorphic function
- Improve the habitat value of the barrier islands
- Increase sediment into the longshore transport process
- Restore diversity of the barrier island habitats

Many of the above opportunities can be utilized in combination with planned or existing projects to produce synergistic effects while minimizing disruptions to the surrounding ecosystem and economy.

2.4 PLANNING OBJECTIVES

For the LCA 2004 Study, two tiers of planning objectives were established – hydrogeomorphic and ecosystem objectives. The hydrogeomorphic objectives were:

- Establish dynamic salinity gradients that reflect natural cycles of freshwater availability and marine forcing.
- Increase sediment input from sources outside estuarine basins, and manage existing wetlands and rebuild marsh substrate.
- Maintain or establish natural landscape features and hydrologic processes that are critical to sustainable ecosystem structure and function.

The ecosystem objectives were:

- Sustain productive and diverse fish and wildlife habitats.
- Reduce nutrient delivery to the Continental shelf by routing Mississippi river waters through estuarine basins while minimizing potential adverse effects.

The LCA TBBSR Study Area objectives are a localized and project specific delineation of the LCA objectives. The Terrebonne Basin barrier shoreline is a unique ecosystem that helps to maintain the integrity of the gulf shoreline and protects the interior coast from further degradation. Aside from supporting coastal habitats, the coastal barrier chains in Louisiana are the first line of defense for protecting wetlands, inland bays, and mainland regions from direct effects of wind, waves, and storms. The barrier systems serve multiple defensive purposes to:

- Reduce coastal flooding during periods of storm surge;
- Prevent direct ocean wave attack, which would accelerate rates of erosion and degradation of marshes and other wetlands; and
- Help maintain gradients between saline and freshwater, thereby preserving estuarine systems.

Based on the function of these barrier islands and problems identified for the Terrebonne islands during this study, the following planning objectives were developed to assist the development and evaluation of alternative plans.

- Provide an expanded footprint of minimized barrier island section to provide the geomorphic form and ecologic function of the Terrebonne Basin barrier island, reducing volume loss within the LCA TBBSR Study Area below the historic average (1880 through 2005)
- Restore and improve various barrier island habitats that provide essential habitats for fish, migratory birds, and other terrestrial and aquatic

species, mimicking, as closely as possible, conditions which would occur naturally in the area for the 50 year period of analysis.

- Increase sediment input to supplement longshore sediment transport processes along the gulf shoreline by mechanically introducing compatible sediment, and increasing the ability of the restored area to continue to function and provide habitat for the 50 year period of analysis with minimum continuing intervention.

2.5 PLANNING CONSTRAINTS

Planning constraints relevant to the Study include natural resources limitations such as lack of suitable sediments for restoration; environmental impacts of human activities in the Study Area; infrastructure and cultural resources that must be avoided or relocated; and limitations in the characterization and simulation of environmental processes that determine the effects of alternatives plans. Winds and waves caused by storm events have been known to move artifacts and pipelines on the seafloor of the Gulf of Mexico. Additionally, barrier shoreline systems are dynamic. Each hurricane and winter season will impact the shoreline to varying degrees. Breaches created during a hurricane are often healed through the natural sand transport processes. However, lack of sediment in the Terrebonne barrier system has limited the natural ability of these breaches to close. Throughout the study, the team's analyses attempted to incorporate data relating to these changes. However, the dynamic nature of the shoreline makes it more difficult to accurately simulate and predict the affects of the various alternatives.

2.6 FUTURE WITHOUT PROJECT

The Study, located in LCA Subprovince 3, provides for the restoration of the Timbalier and Isles Dernieres barrier island reaches located in Terrebonne Parish and Lafourche Parish, Louisiana. The Study Area is shown on Figure 2-2.

Isles Dernieres Reach

The Isles Dernieres Reach represents a barrier island arc approximately 22 miles long in Terrebonne Parish and extends from Caillou Bay east to Cat Island Pass. Raccoon Island, Whiskey Island, Trinity Island, East Island, and Wine Island, the primary islands that comprise the Isles Dernieres barrier island reach, are backed by Bay Blanc, Bay Round, Caillou Bay, and Terrebonne Bay, and bordered by the Gulf of Mexico (GOM) on the seaward side. The islands range from approximately 0.1 to 1.2 miles wide and are generally composed of a thin sand cap over a thick mud platform. Elevations are generally low and the islands are frequently overwashed (USACE, 2004c).

The Isles Dernieres have been and continue to be an important commercial and recreational resource for Louisiana and the nation for more than 150 years. The islands support habitats that are critical to the State's commercial fishing industry.

Furthermore, the mineral-rich subsurface below Terrebonne Bay, Lake Pelto, and Timbalier Bay has supported a high concentration of oil and gas wells.

Timbalier Reach

The Timbalier Reach is comprised of Timbalier Island and East Timbalier Island. The two islands are on the western edge of the Lafourche barrier shoreline and are located about 60 miles southwest of New Orleans, Louisiana (Figure 2-2). This barrier island shoreline is approximately 20 miles long and backed by Terrebonne and Timbalier Bay to the north and delimited by Raccoon Pass to the east and Cat Island Pass to the west. The islands range from 0.1 to 0.6 miles wide and have low elevations. The Timbalier Islands support onshore and offshore oil and gas development and production. Oil and gas production facilities are prevalent along East Timbalier Island, while only a few scattered facilities are present along Timbalier Island. Oil and gas canals are present on both islands (USACE, 2004c).

The Timbalier Islands are very dynamic island systems that form the eastern end of the Study Area and are migrating both landward and laterally. The Timbalier Islands are comprised of the Western and Eastern section of Timbalier and East Timbalier Island. Over the last century, Timbalier Island lost most of its area, shrinking from 3,580 acres to 1,349 acres; most of the loss occurred on the bayside. From 1978 to 1988, the island lost an average of 63 acres/yr as result of opposite rates of migration of Gulf and bayside shorelines, that is, the bayside shoreline migrated seaward while the Gulf shoreline migrated landward.

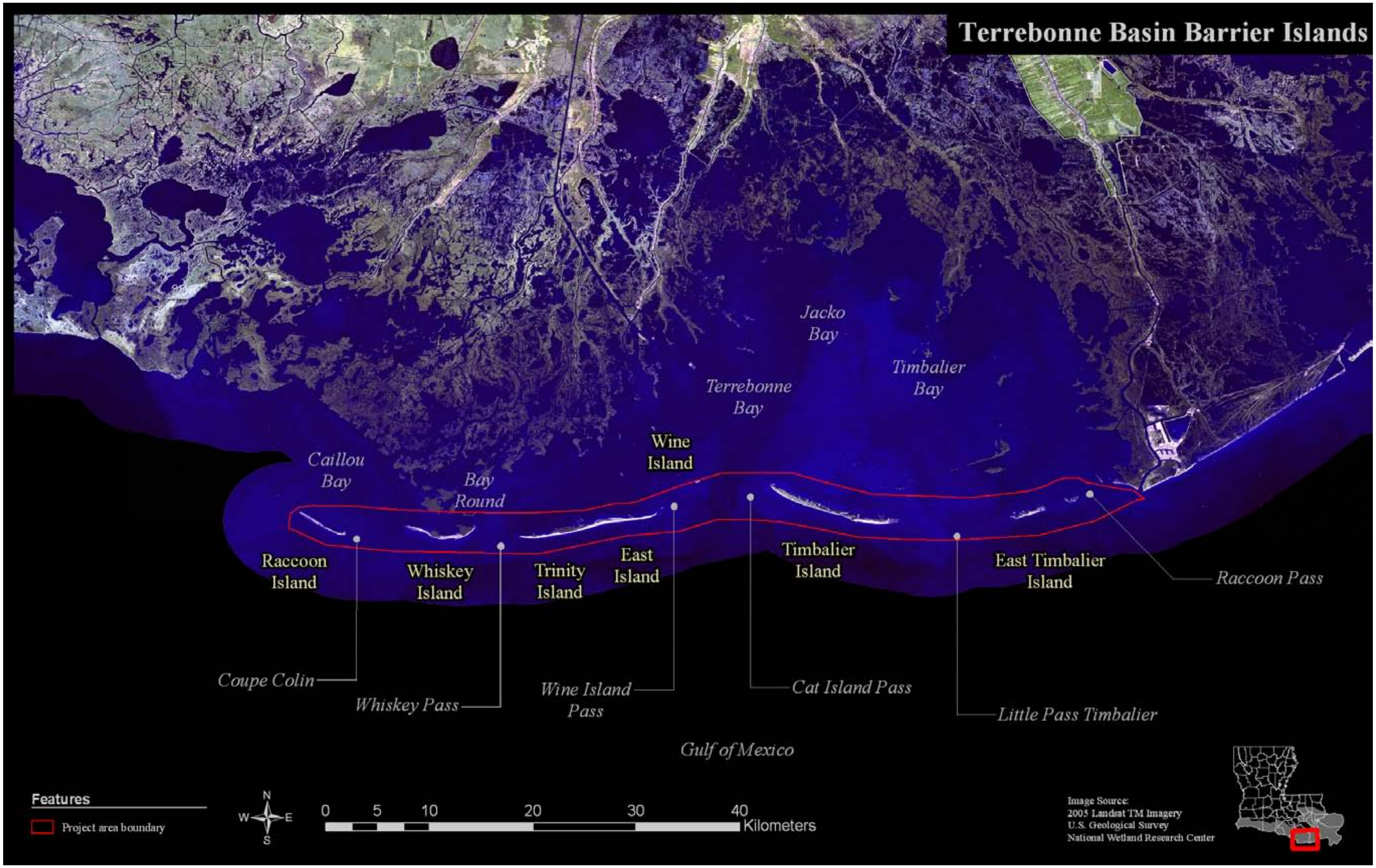

Figure 2-2. Terrebonne Basin Barrier Shoreline Restoration Study Area

Raccoon Island

<u>*Description*</u>

Raccoon Island is approximately 2.6 miles long (USDA, 2007b) and is located at the western end of Isles Dernieres. It is the largest shorebird rookery in the Isles Dernieres. Raccoon Island is characterized by sandy beach with well-vegetated washover terraces backed by thick groves of black mangrove and salt marsh. The recurved spit at the west end is low and dominated by washover flats.

Figure 2-3. Aerial Photograph of Raccoon Island in 2008 (Prior to construction of the TE-49 back barrier marsh)

Figure 2-4. Congregation of seabirds on a breakwater on Raccoon Island

Figure 2-5. Aerial view of existing breakwaters on Raccoon Island

Figure 2-6. Northerly view of existing breakwaters on Raccoon Island

<u>*Proposed Projects*</u>

There are two existing CWPPRA projects that were accounted for in the analysis of Raccoon Island: TE-29 and TE-48. The TE-29 project, which was completed in July 1997, included the construction of eight segmented breakwaters along the eastern end of the island. The TE-48 project consists of two phases. Phase A, which included the construction of eight additional segmented breakwaters and a terminal groin, was completed in September of 2005. The terminal groin, which was constructed on the eastern end of the island, was intended to prevent longshore currents from scouring accumulated sediment behind the breakwater field. Phase B, which is currently in the pre-construction phase, will include the creation of a 53-acre marsh along the backside of the island.

An additional CIAP project, which proposed 16 additional breakwaters on Raccoon Island, was considered, but was not included in the analysis because the plans are preliminary and the State is pursuing the use of these CIAP funds as cost share for the LCA project. No additional projects, including CWPPRA or CIAP projects have been proposed for Whiskey Island.

<u>Landloss</u>

The average historic shoreline change between 1887 and 2002 was –27.4 ft/yr with a range of –28.9 to -24.9 ft/yr. The average short-term shoreline change between 1988 and 2002 was -60.5fy/yr with a range of -144.5 to -8.6 ft/yr (USACE, 2004c). The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana (William et al., 1992) was -28.6 ft/yr.

Since 1978, Raccoon Island rapidly decreased in area from 368.2 to 200.2 acres between 1978 and 1988. During this time period, multiple hurricane impacts occurred in 1979 (Bob and Claudette) and 1985 (Danny, Elena, and Juan). From 1988 to 1992, Raccoon Island further decreased in area from 200.2 acres to 167.8 acres. With the impact of 1992's Hurricane Andrew, the area of Raccoon Island continued to decrease even further to 112.8 acres. By 1993, Raccoon Island had further reduced in area to 99.2 acres. A Federal Emergency Management Agency (FEMA) restoration project constructed in 1994 increased the size of Raccoon Island to 127.2 acres by 1996. An additional segmented breakwater project further increased the area of Raccoon Island to 145.5 acres by 2002. While the hurricane impacts in 2005 (Katrina and Rita) caused erosion, the breakwaters continued to benefit the island (USACE, 2004c). Though an increase in acreage was observed in 2006 (215 acres), the effects of Hurricanes Gustav and Ike reduced Raccoon Island to 121 acres by the winter of 2008 (Barras, 2009).

For this study, the island dimensions and habitat composition of Raccoon Island were determined by applying vertical adjustments (subsidence and sea level rise) and horizontal adjustments (background erosion and overwash) to the existing island footprint for each target year (see Appendix L). The footprint includes 73 acres of existing mangrove stands and the 53-acre marsh component that was constructed as part of TE-48. The horizontal adjustment accounted for the impacts of the existing breakwaters (TE-29 and TE-48). The resulting habitat acreages are summarized in Table 2-1.

Table 2-1. Habitat Acres and Year of Disappearance for Raccoon Island FWOP

Island	Habitat Type	Habitat Acres								YOD[a] (TY)
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	
Raccoon	Dune	0	0	0	0	0	0	0	0	NA
	Supratidal	51	51	30	10	3	0	0	0	TY30
	Intertidal	188	184	161	137	76	55	0	0	TY40

[a]YOD: Year of Disappearance

At TY0, the dimensions of Raccoon Island (i.e. height, width, and depth of each habitat type) are not sufficient to provide geomorphologic form and ecologic function as defined in Section 3.3.2.2.1. As seen in Table 2-1, the island lacks dune habitat (i.e. subaerial acreage greater than +5ft NAVD) and the 51 acres of supratidal habitat is expected to disappear by TY30. By TY40, the 188 acres of intertidal habitat will be gone, including the 73 acres of existing mangrove stands that were observed on the island during the November 2008 and July 2009 site visits. Therefore, if no additional actions are taken, the year of disappearance (YOD) for the entire island is TY40.

<u>*Future Ecosystem Losses Without Project*</u>

If no action is taken to restore Raccoon Island, the following significant environmental resources will be lost that have institutional, public, and technical importance.

- Westernmost end of the Isles Dernieres Barrier Island Refuge
- Second largest nesting colony of brown pelicans in Louisiana (Linscombe, 1993)
- Largest species diversity of aquatic birds of any single island in Louisiana and perhaps North America (Linscombe, 1993)
- Critical habitat for piping plover
- 188 acres of Essential Fish Habitat (EFH) and highly productive marsh
- 51 acres of supratidal habitat utilized by the brown pelican as a rookery and by migrating birds as resting areas
- Storm surge protection for western Terrebonne Parish

The following photographs provide an overview of the existing habitats found on Raccoon Island.

Figure 2.7. Brown Pelican rookery on Raccoon Island

Figure 2.8. Representative view of the mangrove habitat on Raccoon Island during nesting season

Whiskey Island

Description

Whiskey Island is located near the middle of five islands in the Isles Dernieres barrier island reach. It is approximately 4.6 miles long (USDA, 2007b) and located approximately 17.5 miles southwest from Cocodrie, Louisiana in Terrebonne Parish.

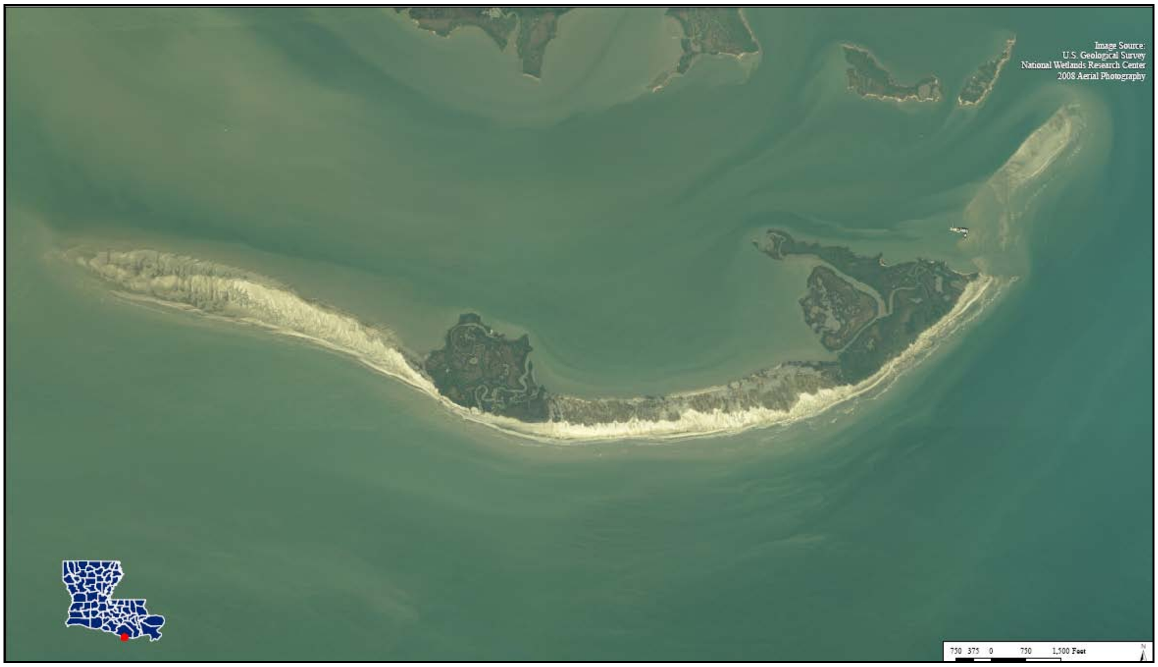

Figure 2.9. Aerial Photograph of Whiskey Island in 2008 (Prior to the construction of TE-50 back barrier marsh))

Proposed Projects

CWPPRA project TE-50 created approximately 316 acres of intertidal back-barrier marsh between the two existing mangrove stands. The project was completed during the course of this Study (October 2009) and was therefore accounted for in the analysis.

An additional CWPPRA project, TE-47, was considered but was not accounted for in the analysis of Whiskey Island. The proposed project would restore the west flank of Whiskey Island, creating a net benefit of 195 acres. Although the Engineering and Design phase has been completed, the project was not approved for construction. No additional projects, including CIAP projects have been proposed for Whiskey Island.

Landloss

The average historic shoreline change rate between 1887 and 2002 was -56.0 ft/yr with a range of -77.5/- 45.7 ft/yr. The average short-term shoreline change rate was -86.0 ft between 1988 and 2002 with a range of -139.4/-48.4 ft/yr (USACE, 2004c). The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana (William et al., 1992) was -42.7 ft/yr.

Prior to restoration, the morphology of Whiskey Island was dominated by washover flats and isolated washover terraces. The CWPRRA restoration project (TE-27) at Whiskey Island created an artificial dune +4 to +6 ft in elevation, which was 2 to 3 ft above the natural pre-restoration surface. As seen throughout the Isles Dernieres, Whiskey Island is historically erosional and decreasing in area. Between 1978 and 1988, Whiskey Island decreased in area from 904.4 acres to 564.2 acres. The hurricanes of 1979 and 1985 were contributing factors to the decrease in area. By 1992, Whiskey Island had decreased to 505.6 acres. During the 1992 hurricane season, Hurricane Andrew impacted this area dramatically, reducing Whiskey Island to 440.8 acres. By 1993 it had further decreased in area to 428.4 acres. Post storm recovery processes increased the area of Whiskey Island to 474.8 acres by 1996. Construction of the Whiskey Island project (TE-27) began in February 1998 and was completed in August 1998. By 2002, the area of Whiskey Island had increased to 642.8 acres, a 36% increase in area. While the hurricanes in 2005 impacted the island, overwash processes and longshore sediment transport from Trinity and East Islands benefited Whiskey Island (USACE, 2004c). The effects of Hurricanes Gustav and Ike decreased the area of Whiskey Island to 509 acres.

For this study, the island dimensions and habitat composition of Whiskey Island were determined by applying vertical adjustments (subsidence and sea level rise) and horizontal adjustments (background erosion and overwash) to the existing island footprint for each target year (see Appendix L). The footprint includes the 316-acre marsh component that was constructed as part of TE-50. Table 2-2 summarizes the habitat acreages computed for Whiskey Island for the period of analysis.

Table 2-2. Habitat Acres and Year of Disappearance for Whiskey Island FWOP

Island	Habitat Type	Habitat Acres								YOD[a] (TY)
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	
Whiskey	Dune	0	0	0	0	0	0	0	0	NA
	Supratidal	377	367	40	4	0	0	0	0	TY17
	Intertidal	443	436	692	616	468	375	0	0	TY31

[a]YOD: Year of Disappearance

At TY0, the dimensions of Whiskey Island (i.e. height, width, and depth of each habitat type) are not sufficient to provide geomorphologic form and ecologic function as defined in Section 3.3.2.2. As seen in Table 2-2, the island lacks dune habitat (i.e. subaerial acreage greater than +5ft NAVD) and the 377 acres of supratidal habitat is expected to disappear by TY17. By TY31, the 443 acres of intertidal habitat will be gone, including the 286 acres of existing mangrove stands that were observed on the island during the November 2008 and July 2009 site visits. Therefore, if no additional actions are taken, the year of disappearance (YOD) for the entire island is TY31.

<u>*Impacts of Landloss*</u>
If no action is taken to restore Whiskey Island, significant environmental resources will be lost that have institutional, public, and technical importance.

- 443 acres of Essential Fish Habitat (EFH)
- Critical habitat for piping plover
- 377 acres of supratidal habitat
- Storm surge protection for Terrebonne Parish
- Protection of oil and gas infrastructure

The following are representative photographs of habitats and features found on Whiskey Island.

Figure 2-10. Oil and gas facility located east of Whiskey Island

Figure 2-11. Back barrier marsh and mangrove habitat found on Whiskey Island

Figure 2-12. Oyster reefs located behind Whiskey Island

Trinity Island

<u>Description</u>

Trinity Island, the largest island of the Isles Dernieres, is approximately 5.2 miles long (USDA, 2007b) and lies immediately to the east of Whiskey Island. The morphology includes low dune terraces, with isolated dunes of up to 3 to 4 ft in elevation. Overwash is more frequent at the west and east ends of the island where elevations decrease. It is a remnant of the original mainland marsh and well-vegetated by black mangroves and salt marsh species. Trinity Island is historically eroding. Between 1978 and 1988, Trinity Island decreased in area from 1,317.1 acres to 894.6 acres. This was a time period of multiple hurricanes in occurring in 1979 and 1985. By 1992, Trinity Island further decreased to 796.5 acres. During the 1992 hurricane season, Hurricane Andrew impacted this area, reducing Trinity Island to 678.5 acres and by 1993, the island decreased further to 651.4 acres. By 1996, the area of Trinity Island continued to decrease to 617.4 acres. Trinity Island increased in area from 617.4 to 710.1 in 2002 as a result of a restoration project constructed on the western end of the islands (USACE, 2004c). Though the impacts of Hurricanes Katrina and Rita were offset by the New Cut Project in 2006 (increasing Trinity Island to 764 acres), the effects of Hurricanes Gustav and Ike decreased the total area of the island to 509 acres by 2008 (Barras, 2009).

Figure 2-13. Aerial Photograph of Trinity Island in 2008

<u>*Proposed Projects*</u>

A beach and back barrier marsh restoration project for Trinity and East Island was presented at the CWPPRA Task Force Meeting in January 2006, but was not selected for CIAP funding. Therefore, the project was not included in the Trinity Island analysis. No additional projects, including CWPPRA or CIAP projects have been proposed for Trinity Island at this time.

<u>*Landloss*</u>

The average historic shoreline change rate between 1887 and 2002 was -38.4 ft/yr with a range of -47.9/-34.3 ft/yr. The 1988–2002 average short-term change rate was -62.5 ft/yr with a range of -107.3/-41.1 ft/yr. The acceleration between the long-term and short-term shoreline change rates is linked to the major hurricane impacts of 1992 and 2002 (USACE, 2004c). The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana (William et al., 1992) was -39.7 ft/yr.

For this study, the island dimensions and habitat composition of Trinity Island were determined by applying vertical adjustments (subsidence and sea level rise) and horizontal adjustments (background erosion and overwash) to the existing island footprint for each target year (see Appendix L). Table 2-3 summarizes the habitat acreages computed for Trinity Island for the period of analysis.

Table 2-3. Habitat Acres and Year of Disappearance for Trinity Island FWOP

Island	Habitat Type	Habitat Acres								YOD[a] (TY)
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	
Trinity	Dune	39	32	4	3	0	0	0	0	TY20
	Supratidal	232	206	137	52	3	1	0	0	TY33
	Intertidal	311	326	327	245	72	19	0	0	TY40

[a]YOD: Year of Disappearance

At TY0, the dimensions of Trinity Island (i.e. height, width, and depth of each habitat type) are not sufficient to provide geomorphologic form and ecologic function as defined in Section 3.3.2.2.1. As seen in Table 2-3, the island has 39 acres dune habitat, 232 acres of supratidal habitat, and 311 acres of intertidal habitat. The dune habitat is expected to disappear by TY20 and most of the supratidal habitat will disappear by TY20. By TY40, the 311 acres of intertidal habitat will be gone. Therefore, if no additional actions are taken, the year of disappearance (YOD) for the entire island is TY40.

<u>Future Ecosystem Losses Without Project</u>
If no action is taken to restore Trinity Island, significant environmental resources will be lost that have institutional, public, and technical importance.

- 311 acres of Essential Fish Habitat (EFH)
- Critical habitat for piping plover
- 232 acres of supratidal habitat
- Storm surge protection for Terrebonne Parish
- Protection of oil and gas infrastructure

Figure 2-14. Northerly view of and oil and gas facility protected by Trinity Island

Figure 2-15. Southeasterly view of Trinity Island

Figure 2-16. Typical view of the mangrove community on Trinity Island

Figure 2-17. Remnant of a fishing camp on Trinity Island

Figure 2-18. One of the many raccoons that inhabit Trinity Island

Figure 2-19. Statue of Mary placed on Trinity Island by the Whiskey Pass Redfish Association

Figure 2-20. One of the many shorebirds that utilize Trinity Island

East Island

Description

East Island is approximately 3.1 miles long (USDA, 2007b) and is the easternmost island of the Isles Dernieres. It is characterized by low dunes and washover terraces, with elevations ranging from +3 to +5 North American Vertical Datum 1988 (NAVD 88).

Figure 2-21. Aerial Photograph of East Island In 2008

Proposed Projects
A beach and back barrier marsh restoration project for Trinity and East Island was presented at the CWPPRA PPL 16 in January 2006, but was not selected for CIAP funding. Therefore, the project was not included in the East Island analysis. No additional projects, including CWPPRA or CIAP projects have been proposed for East Island at this time.

Landloss
Prior to restoration, East Island was rapidly eroding and decreasing in area since 1887. In 1978, East Island was 368.2 acres in area and by 1988 it had decreased in size to 202.2 acres. The average historic shoreline change between 1887 and 2002 was -17.0 ft/yr with a range of - 34.6/-5.1 ft/yr. Short-term, between 1988 and 2002, the average shoreline erosion rates accelerated to -38.6 ft/yr with a range of -64.0/-14.0 ft/yr. During this period of time multiple hurricane impacts occurred in 1979 and in 1985. The 1985 impacts prompted island restoration efforts by way of the LCA TBBSR Study (USACE, 2004c). The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana (William et al., 1992) was -39.7 ft/yr.

By 1992, East Island had continued to lose land and measured 173.4 acres in size. After Hurricane Andrew made landfall in 1992, East Island was further reduced to 93.4 acres, and this continued into 1993 when East Island reached 88.5 acres in size. Following Hurricane Andrew, FEMA did an emergency restoration project east of the former Terrebonne Parish restoration site, resulting in East Island enlarging from 88.5 acres in 1993 to 193.1 acres in 1996. The CWPPRA East Island restoration was completed in 1998, and the area of the island increased from 193.1 acres to 380.4 acres by 2002 (USACE, 2004c). By 2008 East Island decreased to approximately 300 acres due to the hurricane impacts in 2005 and 2008.

For this study, the island dimensions and habitat composition of East Island were determined by applying vertical adjustments (subsidence and sea level rise) and horizontal adjustments (background erosion and overwash) to the existing island footprint for each target year (see Appendix L). Table 2-4 summarizes the habitat acreages computed for East Island for the period of analysis.

Table 2-4. Habitat Acres and Year of Disappearance for East Island FWOP

Island	Habitat Type	Habitat Acres								YOD[a] (TY)
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	
East	Dune	35	23	5	4	0	0	0	0	TY20
	Supratidal	178	176	86	46	6	0	0	0	TY29
	Intertidal	71	59	110	101	58	16	0	0	TY40

[a]YOD: Year of Disappearance

At TY0, the dimensions of East Island (i.e. height, width, and depth of each habitat type) are not sufficient to provide geomorphologic form and ecologic function as defined in Section 3.3.2.2.1. As seen in Table 2-4, the island has 35 acres dune habitat, 178 acres of supratidal habitat, and 71 acres of intertidal habitat. The dune habitat is expected to disappear by TY20 and most of the supratidal habitat will disappear by TY20. By TY40, the 71 acres of intertidal habitat will be gone. Therefore, if no additional actions are taken, the year of disappearance (YOD) for the entire island is TY40.

Future Ecosystem Losses Without Project
If no action is taken to restore East Island, significant environmental resources will be lost that have institutional, public, and technical importance.

- 71 acres of Essential Fish Habitat (EFH)
- Critical habitat for piping plover
- 178 acres of supratidal habitat
- Storm surge protection for western Terrebonne Parish
- Protection of oil and gas infrastructure

Wine Island

Description
Wine Island, located approximately 2.5 miles northeast of East Island and 3.9 miles west of Timbalier Island, lies on Wine Island Shoal, with Wine Island Pass to the west and Cat Island Pass to the east. Historically, Wine Island was the easternmost of the Isles Dernieres. It was approximately three miles in length, and located across the mouth of the present Wine Island/Cat Island Pass (Penland, et al., 2005). By the mid-20th Century the island had migrated north and eroded away. What is now called Wine Island is a dredge spoil disposal site, associated with the Houma Navigation Canal (HNC). In 1991 the present configuration was created when the South Terrebonne Tidewater Management and Conservation District (District) constructed the rock containment dike and the USACE filled it with dredge spoil from the HNC. The original restoration created a 24-acre island, approximately 1,500 ft, east to west. The island was vegetated with a mixture of cordgrass, black mangrove, and ryegrass by the District and the Coastal Restoration Division of the Louisiana Department of Natural Resources in the same year. In 1992 Hurricane Andrew overwashed the island, decimated the vegetation, and washed approximately one-third of the land away. Plans for additional rock structures, dredge spoil placement, and vegetation planting never materialized and responsibility for the island was transferred to the Louisiana Department of Wildlife and Fisheries. The present island is small; approximately 800 ft in east-west dimension. The island is no longer contained within the revetment: its area has been reduced significantly and its footprint has migrated north such that about one third of it presently lies outside the subcircular ring of rocks.

The island is a thriving bird rookery. There is strong public sentiment, from Terrebonne Parish residents and Parish government, to protect and expand Wine Island.

Figure 2-22. Aerial Photograph of Wine Island in 2008

<u>*Proposed Projects*</u>
The Wine Island Restoration project was nominated by the Louisiana Department of Wildlife and Fisheries (LDWF) for CIAP funding. The project would increase the size of Wine Island through the use of hydraulically dredged material from the Houma Navigation Canal. Due to the uncertainty of project implementation, the Wine Island Restoration project was not included in the analysis. Furthermore, the State is pursuing the use of these CIAP funds as cost share for the LCA project. No additional projects, including CWPPRA or CIAP projects have been proposed for Wine Island at this time.

<u>*Land loss*</u>
It is unknown if the present land mass has been supplemented by subsequent dredge spoil disposal. Its low relief and sparse vegetation point to periodic overwash, as does its ongoing migration out of the encircling rock revetment. The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana (William et al., 1992) was -21.6 ft/yr. Table 2-5 summarizes the habitat acreages computed for Wine Island for the period of analysis.

Table 2-5. Habitat Acres and Year of Disappearance for Wine Island FWOP

Island	Habitat Type	Habitat Acres								YOD[a] (TY)
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	
Wine	Dune	1	0	0	0	0	0	0	0	TY1
	Supratidal	6	4	3	2	1	0	0	0	TY29
	Intertidal	6	7	6	5	3	1	0	0	TY35

[a]YOD: Year of Disappearance

At TY0, the dimensions of Wine Island (i.e. height, width, and depth of each habitat type) are not sufficient to provide geomorphologic form and ecologic function as defined in Section 3.3.2.2.1. As seen in Table 2-5, the island has 1 acres of dune habitat, 5 acres of supratidal habitat, and 6 acres of intertidal habitat. The dune habitat is expected to disappear by TY1 and most of the supratidal habitat will disappear by TY29. By TY35, the six acres of intertidal habitat will be gone. Therefore, if no additional actions are taken, the year of disappearance (YOD) for the entire island is TY35.

<u>*Future Ecosystem Losses Without Project*</u>

If no action is taken to restore Wine Island, significant environmental resources will be lost that have institutional, public, and technical importance.

- 6 acres of Essential Fish Habitat (EFH)
- Critical habitat for piping plover
- 5 acres of supratidal habitat utilized by the brown pelican and numerous other shorebirds
- Storm surge protection for western Terrebonne Parish
- Protection of oil and gas infrastructure

Figure 2-23. View of a brown pelican rookery on Wine Island

Figure 2-24. Typical view of the habitat found on Wine Island and the nesting brown pelicans

Timbalier Island

Timbalier Island is approximately 7 miles long (USDA, 2007b) and lies in Terrebonne and Lafourche Parishes. Historical maps of shoreline change have provided insight into the erosion process during the rapid westward migration by Timbalier Island. Over the last 115 years, Timbalier Island has migrated 2.5 miles to the west by the erosion of its east end and the recurve spit extension of its west end. With this westward migration, Timbalier Island has developed two distinct shoreline change rate regimes (USACE, 2004c).

Figure 2-25. Aerial Photograph of Timbalier Island in 2008

<u>*Proposed Project*</u>

The goal of CWPPRA project TE-53 (Enhancement of Barrier Island Vegetation Demonstration) is to develop cost-effective methods for enhancing vegetative establishment and growth on barrier island restoration projects. Currently, this project is in the planning phase. Two possible project sites have been proposed – the site of the Timbalier Island Dune and Restoration project (TE-40), and the New Cut Dune and Marsh Restoration project (TE-37) site (LDNR, 2009b). TE-53 is currently waiting project phase authorization.

Due to the uncertainty of project implementation, CWPPRA project TE-53 was not included in the analysis for the island. No additional projects, including CWPPRA or CIAP projects have been proposed for Timbalier Island at this time.

<u>*Landloss*</u>

The average historic rate of shoreline change for the eastern portion of Timbalier Island was -42.9 ft/yr between 1887 and 2002 with a range of -48.6/-37.3 ft/yr. Between 1988 and 2002, the average short-term erosion rate accelerated to -179.4 ft/yr with a range of -205.5/-153.3 ft/yr for the eastern portion. The high rates of negative change reflect the impact of the 1992 and 2002 hurricanes. Conversely, with the western migration of Timbalier Island, the western portion of the island has historically shown a lower rate of shoreline change. The average historic erosion rate for the western portion is -4.1 ft/yr with a range of -31.0/+20.9 ft/yr between

1887 and 2002. The western portion has experienced an average short-term erosion rate between 1988 and 2002 of 13.4 ft/yr with a range of -118.7/+31.9 ft/yr. The combination of the 1985/1992/2002 hurricanes and disruption of the westward sediment transport by the Belle Pass jetties have all contributed to the high rates of shoreline change in this area (USACE, 2004c). The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana (William et al., 1992) was -32.5 ft/yr.

For this study, the island dimensions and habitat composition of Timbalier Island were determined by applying vertical adjustments (subsidence and sea level rise) and horizontal adjustments (background erosion and overwash) to the existing island footprint for each target year (see Appendix L).Table 2-6 summarizes the habitat acreages computed for Timbalier Island for the period of analysis.

Table 2-6. Habitat Acres and Year of Disappearance for Timbalier Island FWOP.

Island	Habitat Type	Habitat Acres								YOD[a] (TY)
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	
Timbalier	Dune	57	53	31	8	0	0	0	0	TY20
	Supratidal	549	529	266	286	93	18	1	0	TY46
	Intertidal	374	373	541	392	289	149	37	2	>TY50

[a]YOD: Year of

At TY0, the dimensions of Timbalier Island (i.e. height, width, and depth of each habitat type) are not sufficient to provide geomorphologic form and ecologic function as defined in Section 3.3.2.2.1. As seen in Table 2-6, the island has 57 acres of dune habitat, 549 acres of supratidal habitat, and 374 acres of intertidal habitat. The dune habitat is expected to disappear by TY20 and most of the supratidal habitat will disappear by TY40. By TY50, all but two acres of intertidal habitat will be gone.

<u>*Future Ecosystem Losses Without Project*</u>

If no action is taken to restore Timbalier Island, significant environmental resources will be lost that have institutional, public, and technical importance.

- 374 acres of Essential Fish Habitat (EFH)
- Critical habitat for piping plover
- 549 acres of supratidal habitat
- Storm surge protection for eastern Terrebonne and Lafourche Parishes
- Protection of oil and gas infrastructure

Figure 2-26. View of the sand dunes created on Timbalier Island during a recent restoration project

Figure 2-27. Shoreline protection feature located on Timbalier Island

Figure 2-28. View of the many shorebirds that utilize Timbalier Island

East Timbalier Island

East Timbalier Island is approximately 3.6 miles long (USDA, 2007b) and lies east of Little Pass Timbalier and directly west of the Bayou Lafourche headland. East Timbalier Island is occupied by a major oil and gas operation at the inshore Timbalier Bay Field. The island and surrounding bay supports major offshore production facilities. East Timbalier Island is known for the massive rip-rap seawall along its Gulf shoreline and numerous revetments landward of it. The combination of the position of East Timbalier Island immediately downdrift of the Bayou Lafourche headland and the Belle Pass jetties create one of the most erosional areas in coastal Louisiana (USACE, 2004c).

Figure 2-29. Aerial Photograph of East Timbalier Island in 2008

<u>*Proposed Project*</u>
There are two proposed CIAP project on East Timbalier. The first project proposes the creation of approximately of 3,200 linear feet of segmented breakwaters, 190 acres of supratidal habitat, and 180 acres of intertidal habitat. The second project would close a breach in the island and rebuild a larger, wider dune and beach along the gulfward shoreline.

Due to the uncertainty of project implementation, neither project was included in the analysis. No additional projects, including CWPPRA or CIAP projects have been proposed for East Timbalier Island at this time.

<u>*Landloss*</u>
The average historic erosion rate between 1887 and 2002 was -61.2 ft/yr with a range of -74.3 to -49.2 ft/yr. The average short-term erosion rate between 1988 and 2002 decreased to -36.3 ft/yr with a range of -65.5 to -4.9 ft/yr. The erosion rate diminished here in spite of the 1992 and 2002 hurricanes. This shoreline erosion decrease is partially related to the construction of CWPPRA restoration project TE-25/30 in 2000, which created approximately 109 acres of new land (USACE, 2004c). The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana (William et al., 1992) was -21.4 ft/yr.

For this study, the island dimensions and habitat composition of East Timbalier Island were determined by applying vertical adjustments (subsidence and sea level rise) and horizontal adjustments (background erosion and overwash) to the existing island footprint for each target year (see Appendix L). Table 2-7 summarizes the habitat acreages computed for East Timbalier Island for the period of analysis.

Table 2-7. Habitat Acres and Year of Disappearance for East Timbalier Island FWOP

Island	Habitat Type	Habitat Acres								YOD[a] (TY)
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	
East Timbalier	Dune	7	1	1	0	0	0	0	0	TY10
	Supratidal	129	74	60	46	9	2	1	0	TY43
	Intertidal	173	133	140	111	98	49	17	4	>TY50

[a]YOD: Year of Disappearance

At TY0, the dimensions of East Timbalier Island are not sufficient to provide geomorphologic form and ecologic function as defined in Section 3.3.2.2.1. As seen in Table 2-7, the island has 7 acres of dune habitat, 129 acres of supratidal habitat, and 173 acres of intertidal habitat. The dune habitat is expected to disappear by TY10 and the supratidal habitat will disappear by TY43. By TY50, all but four acres of intertidal habitat will be gone.

<u>*Future Ecosystem Losses Without Project*</u>

If no action is taken to restore East Timbalier Island, significant environmental resources will be lost that have institutional, public, and technical importance.

- 173 acres of Essential Fish Habitat (EFH)
- Critical habitat for piping plover
- 129 acres of supratidal habitat
- Storm surge protection for western Lafourche Parish
- Protection of oil and gas infrastructure

Figure 2-30. View of the oil and gas facilities protected by East Timbalier Island

Figure 2-31. Aerial view facing north of the western tip of East Timbalier Island

3.0 ALTERNATIVES

3.1 Plan Formulation Rationale

3.1.1 Plan Formulation Rationale

Alternatives for the proposed action were formulated in consideration of Study Area problems and opportunities, as well as study goals, objectives and constraints. As specified in ER 1105-2-100, four criteria were considered during alternative plan screening: completeness, effectiveness, efficiency, and acceptability.

3.1.2 Plan Formulation Criteria

3.1.2.1 Completeness

Completeness is the extent that an alternative provides and accounts for all investments and actions required to ensure the planned output is achieved. This criterion may require comparison of the plan to other public and private plans if those plans affect the outcome of the project. Completeness also includes consideration of real estate issues, O&M, monitoring, and sponsorship factors. Adaptive management plans formulated to address Study uncertainties also have to be considered.

3.1.2.2 Effectiveness

Effectiveness is defined as the degree to which the plan will achieve the planning objective. The plan must make a significant contribution to the problem or opportunity being addressed.

3.1.2.3 Efficiency

The Study must be a cost-effective means of addressing the problem or opportunity. The plan outputs cannot be produced more cost-effectively by another institution or agency.

3.1.2.4 Acceptability

A plan must be acceptable to Federal, State, and local government in terms of applicable laws, regulation, and public policy. The Study should have evidence of broad-based public support and be acceptable to the non-Federal cost sharing partner.

3.1.3 Environmental Operating Principles

In 2002, the USACE formalized a set of Environmental Operating Principles applicable to decision-making in all programs. The principles are consistent with

NEPA; the Army Strategy for the Environment; other environmental statutes, and the WRDAs that govern USACE activities. The Environmental Operating Principles inform the plan formulation process and are integrated into all project management processes. Alternatives were formulation for this Study consistent with the Environmental Operating Principles.
The USACE Environmental Operating Principles are:

- Strive to achieve environmental sustainability, and recognize that an environment maintained in a healthy, diverse, and sustainable condition is necessary to support life;
- Recognize the interdependence of life and the physical environment, and proactively consider environmental consequences of USACE programs and act accordingly in all appropriate circumstances;
- Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another;
- Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that impact human health and welfare and the continued viability of natural systems;
- Seek ways and means to assess and mitigate cumulative impacts to the environment and bring systems approaches to the full life cycle of our processes and work;
- Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts of our work; and
- Respect the views of individuals and groups interested in USACE activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the Nation's problems that also protect and enhance the environment.

3.2 Management Measures

Management measures were developed to address Study Area problems and to capitalize upon Study Area opportunities. A management measure is a feature or an activity that can be implemented at a specific geographic site to address one or more planning objectives. A management measure can be combined with other management measures to form island strategy, which were then combined to form alternative plans.

3.2.1 Development of Management Measures

Management measures were derived from a variety of sources including prior restoration projects, prior studies, the National Environmental Policy Act (NEPA) public scoping process, and the multidisciplinary, interagency project delivery team (PDT) consisting of experts from State and Federal agencies and the private sector. Various permutations of scales and locations were considered.

As part of the Feasibility Scoping Meeting planning step, a Value Engineering (VE) study was conducted to identify potential modifications of restoration measures and plan configurations that could improve the performance and cost effectiveness of the preliminary alternatives (VMS, 2009). The results of the VE study for the project were fully considered and used to refine the conceptual alternative plans during alternative plan formulation.

In order to develop a reasonable set of alternatives for the LCA TBBSR Study, a wide range of management measures was first identified. Experience of the PDT along with information presented in the VE study, comments from the public scoping meeting, and supporting data (e.g. geospatial data, surveys, previous restoration projects and measures) were used to establish the list of strategies and measures that were assessed during the screening process. The management measures were divided into hard- and soft- structural measures. The following sections present the descriptions of the management measures that were considered.

3.2.2 Description of Management Measures

3.2.2.1 Hard-Structural Measures

3.2.2.1.1 Breakwaters

The main function of breakwaters is to trap sand by reducing wave energy behind the structure, therefore slowing littoral drift and often creating a salient or tombolo behind the structure. The following variations of breakwaters were evaluated:

- Segmented Breakwaters (specific location)
- Continuous Breakwaters (specific location)
- Segmented Breakwaters (entire island)
- Continuous Breakwaters (entire island)

3.2.2.1.2 Revetments

The purpose of revetments is to protect upland property. The structures are constructed as rubble mounds, with a stone size determined by analysis of the wave climate.

Revetments limit the movement of sediment from behind the revetment to the active littoral system seaward of it. Due to the energy dissipating nature of rubble mound, revetments considerably reduce the probability of scour. Revetments may be utilized in a continuous or segmented orientation (USACE, 2004c). The following variations of revetments were evaluated:

- Segmented Revetments (specific location)
- Continuous Revetment (specific location)
- Segmented Revetments (entire island)
- Continuous Revetment (entire island)

3.2.2.1.3 Shoreline Groins

Shoreline groins are shore-perpendicular structures that are designed to trap longshore sediment transport. They have been constructed from many different materials including steel sheet piles, concrete sheet piles, wood panels with wood piles, and rubble mounds (including concrete roadway and sidewalk debris). Shoreline groins are typically designed to extend from the dry beach across the surf zone (USACE, 2004c).

3.2.2.1.4 Terminal Groins

Terminal groins are structures constructed perpendicular to the shoreline at the ends of barrier islands or littoral cells. They can also be located adjacent to non-stabilized inlets in order to avoid or minimize sediment losses to these water bodies.

3.2.2.1.5 Sand Fencing

Sand fences are typically an integral part of dune restoration projects and are sited on the dune, where they are less susceptible to wave energy. Sand fences capture the aeolian transport of fine grain sand and add elevation to the dune as the sand accumulates.

3.2.2.1.6 Sunken Barges/ships

This measure consists of utilizing barges or ships as an unconventional breakwater. These structures can be used both in a sunken or floating configuration. Sunken barges/ships are often filled with rocks and/or water and placed in a shore-parallel orientation.

3.2.2.1.7 Floating Barges/ships

This measure consists of utilizing barges or ships as an unconventional breakwater. The floating vessels would be anchored or moored in a shore-parallel orientation.

3.2.2.1.8 Sheet Pile

A sheet pile wall is a row of interlocking, vertical piles driven to form a straight wall or bulkhead, often strengthened by a horizontal cap or wale (USACE, 1994). These structures, which can be built from steel, aluminum, timber, or concrete, are used as effective means of stabilizing a shoreline that is subject to low-moderate waves. Sheet piles are typically driven at the toe of the fill or structure to resist scour at its base. They are curved or stepped face to limit wave overtopping, and are sometimes backfilled to raise the land elevation behind the structure (Sorensen et al., 1984). The following variations of sheet pile were evaluated:

- Segmented Sheet Pile (specific location)
- Continuous Sheet Pile (specific location)
- Segmented Sheet Pile (entire island)
- Continuous Sheet Pile (entire island)

3.2.2.1.9 Pass Closures

Pass closures would consist of closing navigable passes via hardened structural methods. These measures would reduce the tidal prism and salinity intrusion in the estuary.

3.2.2.1.10 Canal Plugs

Placing plugs in strategic locations can isolate interior marshes and back-barrier features from hydrologic influences. Earthen plugs can be used to close off waterways, and when access is needed, they can be removed and subsequently replaced. Such arrangements are typically more cost-effective than structures such as floodgates.

3.2.2.2 Soft-Structural Measures

3.2.2.2.1 Dune Restoration

This measure consists of construction of a sand dune system using external sediment sources. Sediment of suitable grain size and physical properties is dredged from offshore sources and transported to the restoration location. The material is then placed along the shoreline reach to restore the dune profile of the barrier shoreline as specified in the topographic profile developed for the restoration plan. Containment structures may be used to control placement of sediment. This measure would recreate the dune system and restore the form and function of the shoreline.

3.2.2.2.2 Marsh Creation

This measure consists of construction of containment dikes, using in situ sediment, and creation of a marsh platform using sediment of suitable grain size and physical properties transported to the marsh location from an external source. Marsh platforms landward of barrier shorelines provide a foundation for rollover of the dune ridge and beach shoreface, allowing the barrier shoreline to migrate landward in response to storms, waves, and currents. The migrating shoreface material continues to provide benefits even though some wetland loss occurs during the rollover process.

3.2.2.2.3 Beach Restoration (depth of closure to dune)

This measure consists of widening the existing shoreline and profile to the closure depth, using sediment of suitable grain size and physical properties transported to the restoration site from an external source. This enhancement provides protection to the dune while also providing sediment in the littoral system to feed down drift beaches.

3.2.2.2.4 Subtidal Sediment Placement

This form of beach restoration involves placing stockpiles of sand in strategic subtidal locations. The method has a lower initial construction cost, but requires more maintenance because coastal processes move the material not only down the beach but also offshore, causing greater loss of material. Subtidal sediment placement has the same reasons for implementation as beach restoration and the same advantages and disadvantages (USEPA, 1997a).

3.2.2.2.5 Addition of Sediment into Near-shore Environment

This method involves the placement of beach fill material in a sand bar just offshore of the surf zone. To be successful, the placement must be within the active portion of the beach profile. The sand will gradually move onshore under the influence of waves and currents, increasing the beach width.

3.2.2.2.6 Breach Closure

This measure involves the placement of dredged material into breaches in the barrier island, most often caused by hurricanes. Positive environmental benefits include the conversion of intertidal habitat to supratidal and dune habitat. If left unmitigated, breaches usually widen rapidly and may turn into tidal passes. The closing of breaches fortifies and stabilizes the island, while protecting existing intertidal habitat. The New Cut Dune/Marsh Restoration Project (TE-11a/TE-37), located between East Island and Trinity Island is an example of a recently-constructed breach closure project.

3.2.2.2.7 Small Marsh Island Construction on Bayside for Bird Habitat

This measure consists of using dredged material to build small islands on the bay side of the barrier island reach. The measure was proposed as an emergency restoration to replace lost bird habitat on Raccoon Island, following Hurricane Andrew (USEPA, 1993).

3.2.2.2.8 Vegetation Planting

Vegetation plantings are a typical component of barrier island dune and marsh restoration projects, and are often installed to stabilize dredged material and supplement natural colonization and recruitment.

3.2.2.2.9 Herbivore Control

This measure is used to reduce the damage to coastal wetlands caused by the South American herbivorous rodent, Myocastor coypus (Nutria). Examples of this measure are an incentive payment program to encourage nutria harvesting and measures implemented on-site, such as wire mesh cages to retard herbivory.

3.2.2.2.10 Bio-engineered Oyster Reefs

This measure utilizes shell material placed at an elevation that would periodically break the surface of the water, in order to create "islands," as well as substrates for oyster growth. The Louisiana Department of Wildlife and Fisheries recommends using traditional cultch material to rebuild certain islands, eroded points or spits, and relict "shell" islands. These islands or bars provide important habitat for fish and invertebrate species, and, if they become vegetated, important nesting habitat for some species of shore birds.

3.2.2.2.11 Spit Creation (E&T Habitat)

A spit is a linear beach extending from a headland designed to create endangered and threatened species (E&T) habitat. Spit creation may be a viable restoration measure especially if situated where it would benefit from natural longshore sediment transport.

3.2.2.2.12 Backfilling Canals

Canal backfilling involves depositing dredged or bulldozed material (from the canal spoil banks or elsewhere) into a canal. Differentiating this measure from marsh creation is the grade to which the deposited dredge material is elevated (elevation of backfilled canals must coincide with the elevation of the adjacent undisturbed bay-bottom or marsh).

3.2.3 Screening/Evaluation of Management Measures

3.2.3.1 Initial Screening

The identified measures were selected and screened based upon experience with previous restoration efforts, knowledge of the Study Area, conventional scientific theory, best professional judgment, and consideration of the study objectives.

Management measures were first screened based on their ability to meet the following five (5) criteria:

- Consistency with Authorization and Purpose - measure is fully consistent with study authorization and purpose;
- Achievement of Planning Objectives - measure is fully supportive of planning objective(s);
- Efficiency - measure directly influences the area(s) of greatest need;
- Environmental Impacts - measure presents no readily apparent potential for adverse environmental impacts; and

- Engineering Feasibility - measure directly supported by acceptable engineering and industry practices.

These criteria were deemed critical for achieving the Study goals. Each measure that could reasonably achieve the planning objectives was maintained for consideration under the final screening level described in the next section.

3.2.3.1.1 Hard-structural Measures Screening

The following sections describe the hard-structural measures that were evaluated and the application of the screening criteria to either eliminate or carry each measure forward. An important factor that must be considered when evaluating hard structures is the interplay of sea level rise, land subsidence, and the lack of sediment input into the littoral systems. These factors result in a gradual northward or landward movement of some of the barrier islands, or parts of the islands (Penland, et al., 2005). As the distances between the shoreline and fixed offshore erosion prevention measures increase, particularly after major storm events roll the beach/dune system back over the bay or marsh, the measures slowly lose their effectiveness. This, coupled with the lack of suitably supportive foundation substrate in many locations, means that detailed geological investigations must precede any decision regarding use of such measures.

Segmented Breakwaters (Specific Location)

Segmented breakwaters were carried forward for further consideration because this measure, in certain situations, may stabilize the shoreline and significantly reduce shoreline erosion for the protected area. Site-specific modeling should be conducted to ensure that the segmented breakwater will not interrupt the natural longshore sediment transport system and adversely impact adjacent shoreline reaches.

Continuous Breakwaters (Specific Location)

Considerable discussion occurred regarding the long-term, system-wide problems created by some of the proposed hard-structural measures, notably breakwaters. These structures interfere with the normal longshore and cross-shore movement of sediment in the coastal system. They introduce a systemic disruption into the barrier island shoreline processes, one that will likely be beneficial in some situations and detrimental in others. While they may be effective in certain local applications, they may result in increased erosion elsewhere in the system (Dean, 1999; Douglass, 2002; National Research Council, 1995). Due to potential environmental impacts, the indiscriminate installation of continuous breakwaters along entire or partial lengths of island shoreline did not pass screening.

In addition to the potential adverse environmental impacts, these structures do not introduce additional sediment into the already sand-starved system. The conceptual sediment budget for LCA Province III, which extends from the Caminada/Fourchon Headland westward to Vermilion Bay, indicates that sediment moves in a westward direction from the Headland, past the Timbalier Islands then into Terrebonne Bay. The dominant movement in the Isles Dernieres is complex: it moves to the east, into Terrebonne Bay, to the west, into the Isles Dernieres Sink and toward Grand Caillou Bayou, and also to the south, offshore (Rosati, et al., 2008, draft letter report).

Segmented Breakwaters (Entire Island)

Segmented breakwaters placed around an entire island were eliminated from further consideration because they present high a potential for adverse environmental impacts. While the impact from breakwaters may appear to be positive as reduced erosion rates along portions of the shorelines would enhance project performance and potentially increase the interval between re-nourishment events, these benefits would be offset by significant adverse impacts that would result from the interruption of longshore sediment transport. This interference with sediment transport processes would increase the rates of erosion and shoreline retreat to adjacent reaches of the barrier shoreline (USACE, 2009).

Continuous Breakwaters (Entire Island)

Continuous breakwaters placed around an entire island were eliminated from further consideration because of the potential impacts discussed for continuous breakwaters (specific locations).

Segmented Revetments (Specific Location)

Segmented revetments placed at specific locations were eliminated because potential environmental impacts. They will interrupt normal movement of sand along the shoreline, longshore and cross-shore and result in long-term negative impact although they may reduce short-term erosion. Also, rocks placed on sediment can settle significantly. Some form of foundation protection (e.g., rock filled geotextile mats/sheets) is needed to limit this settlement. In some cases, the substrate may be too unstable to support rock structures, even with foundation protection.

Continuous Revetment (Specific Location)

Continuous revetments placed at specific locations were eliminated because of potential environmental impacts. This measure consists of the construction of a rock shoreline. This measure may stabilize the shoreline and may reduce shoreline erosion for the protected area. However, a rock shoreline would adversely impact threatened and endangered species such as the piping plover and the Kemp's Ridley sea turtle, by eliminated nesting and feeding areas (USACE, 2009). The Wetland Value Assessment (WVA) methodology, which quantifies habitat benefits of restoration projects, acknowledges this by assigning a considerably lower surf-zone habitat value for shorelines protected with revetments (CWPPRA, 2002).

Continuous revetments can also adversely impact longshore sediment transport processes. In the 1950s, a continuous rock seawall was placed on the seaward side of East Timbalier Island to protect the island and associated oil and gas infrastructure from wave impacts. However, the seawall disrupted the natural wave processes and distorted the normal nearshore profile. This resulted in the formation of a steep, subaqueous scarp. Due to the seawall and associated scarp, little, if any, sand could be deposited on the beach by longshore transport. This accelerated the natural erosional processes because the sand material winnowed through the seawall was not replaced by longshore sediment transport. Consequently, the beach retreated more quickly from the seawall, leaving it stranded in open water (LGS, 1995). This phenomenon was also described by Penland and Boyd (1981). According to the authors, East Timbalier Island increased size between 1935 and 1956. After the construction of the seawall, the size of the island began rapidly decreasing. The authors attributed the decline to the construction of the seawall rather than cyclone activity.

Also, rocks placed on sediment can settle significantly. Some form of foundation protection (e.g., rock filled geotextile mats/sheets) is needed to limit this settlement. In some cases, the substrate may be too unstable to support rock structures, even with foundation protection. Furthermore, revetments cannot counter the effects of subsidence and sea level rise (LGS, 1995). For this reason, continuous revetments were eliminated from further consideration for Raccoon, Whiskey, Trinity, East, Timbalier, and East Timbalier Islands.

However, Wine Island is unique in that it was once surrounded by a boulder revetment to hold dredged material from the HNC. The island is no longer contained within the revetment. One restoration option being considered by the PDT involves restoring the island within the boulder revetment, through beneficial use of sediment dredged from the HNC. Therefore, continuous revetments will be carried forward for Wine Island only.

Segmented Revetments (Entire Island)

Segmented revetments placed around an entire island were eliminated from further consideration because they present high potential for adverse environmental impacts. This measure may stabilize the shoreline and may reduce shoreline erosion for the protected area. However, a rock shoreline would adversely impact threatened and endangered species such as the piping plover and the Kemp's Ridley sea turtle by eliminating nesting and feeding areas (USACE, 2009). Further, the rock shoreline would interrupt the natural longshore sediment transport system and impact adjacent shoreline reaches not protected by hard stabilization (USACE, 2009). For this reason, segmented revetments placed around the entire island were eliminated from further consideration.

Continuous Revetment (Entire Island)

Continuous revetments were removed from further consideration for the same reasons as the continuous revetments at specific locations.

Shoreline Groin

Although groins in general are not effective in reducing cross-shore erosion (i.e. overwash from beach/dune into and across the back-barrier marsh and mudflats), they are effective in mitigating longshore transport (Kraus et al, 1994). However, during near-normal wave incidences (i.e. during typical storm events), a shoreline groin system can create strong local currents and rip currents which can contribute to the offshore movement of beach materials (USACE, 2008b). Therefore, shoreline groins were eliminated from further consideration.

Terminal Groin

Terminal groins contribute to significantly less storm-induced currents than shoreline groin fields because they consist of a single structure placed at the end of the island. Furthermore, they are effective in reducing longshore erosion by capturing sediment that would otherwise be lost through offshore transport and deposition. Therefore, terminal groins were carried forward for further considerations.

Special consideration must be given to the placement of these features because of the potential adverse impacts that could result from the interruption of longshore sediment transport. This interference with sediment transport processes would increase the rates of erosion and shoreline retreat to adjacent reaches of the barrier shoreline.

Sunken Barges/Ships

Use of surplus ships or barges, whether sunk as a series of breakwaters or anchored to form a nearshore wave-attenuating array, raises a number of engineering and environmental issues. Given the shoaling nature of the nearshore environment, getting barges or vessels into correct positions to function as a detached breakwater system, and then sinking them, would be difficult to achieve with any degree of accuracy and therefore presents a significant engineering feasibility issue. Permitting such a system would also be difficult because of the potential for hazardous materials releases (i.e. environmental impacts), the need for extensive dredging, and other similar issues. The most obvious question about use of anchored vessels is how to ensure that they stay where anchored, particularly considering the magnitude of recent hurricanes and the damage wrought by loose vessels when they are blown ashore. Given the number and scattered distribution of petroleum extraction and processing structures in the Terrebonne Basin and the unknown nature of future storm tracks, the potential for damage from loose vessels must be a serious consideration. Due to these issues, sunken barges/ships were eliminated from further consideration.

Floating Barges/Ships

This measure was eliminated from further consideration because of the potential environmental impacts and engineering feasibility issues discussed for sunken barges/ships.

Segmented Sheet Pile (Specific Location)

Segmented sheet pile was eliminated from further consideration because its long-term effectiveness would be significantly reduced due to local subsidence and historical migration trends. Therefore, it would not meet the planning objectives of the Study. Furthermore, it could potentially interrupt the natural longshore sediment transport and could present adverse environmental impacts to the shoreline reaches.

Continuous Sheet Pile (Specific Location)

Continuous sheet pile was eliminated from further consideration for the same reasons as segmented sheet piles at specific locations.

Segmented Sheet Pile (Entire Island)

Segmented sheet pile was eliminated from further consideration for the same reasons as segmented sheet piles at specific locations.

Continuous Sheet Pile (Entire Island)

Continuous sheet pile was eliminated from further consideration for the same reasons as segmented sheet piles at specific locations.

Pass Closures

Simple hydrodynamic considerations dictate that plugging one pass means that the volume of water it conveyed will have to be accommodated elsewhere, either by existing passes or newly-created breaches. Furthermore, the structures themselves would be highly susceptible to breaching and could disrupt the tidal prism of the system. Therefore, pass closures did not pass the initial level screening because of a lack of efficiency and ability to achieve the planning objectives

Canal Plugs

Canal plugs were carried forward for further consideration because they appeared to be an effective means of preventing breaches and further land loss.

3.2.3.1.2 Soft-structural Measures Screening

The following sections describe the soft-structural measures that were evaluated and the application of the initial level screening criteria to either eliminate or carry each measure forward.

Dune Restoration

Dune restoration is a proven barrier island restoration measure in coastal Louisiana. It met all five of the initial screening criteria and was carried forward for further consideration. Restoring the barrier island system through placement of sand would help mitigate storm damage to natural and man-made components in the Study Area. However, the dune system would continue to erode if other measures such as periodic re-nourishment are not implemented, or until longer-term projects reestablish sediment supply for this region of the Gulf shoreline.

Marsh Creation

Marsh creation is a proven barrier island restoration measure in coastal Louisiana. It met all five of the initial screening criteria and was carried forward for further consideration. Marsh restoration in combination with other barrier island restoration measures would increase the extent of the bay intertidal habitats. Back barrier marshes, along with their related hydrologic and biological processes, provide unique habitats that are crucial to the viability of migratory birds, commercial and recreational fisheries, and a great variety of terrestrial and aquatic species. Marsh platforms constructed landward of barrier shorelines provide a foundation for rollover of the dune ridge and beach shoreface, allowing the barrier shoreline landforms to migrate landward in response to storms, waves, and currents. The migrating shorelines continue to provide benefits even though some wetland loss occurs during the rollover process (USACE, 2009).

Beach Restoration

Beach restoration is a proven barrier island restoration measure in coastal Louisiana. It met all five of the initial screening criteria and was carried forward for further consideration. This measure would restore the shoreface, widen the geomorphic structure of the island, and increase the sediment available for longshore transport which could benefit adjacent barrier shoreline.

Subtidal Sediment Placement

Placement of sediment in the shallow open water areas behind the barrier island would serve similar functions as back-barrier marsh creation. These shallow-water environments would provide critical fish and wildlife habitat as well as provide a foundation for rollover of the dune ridge and beach shoreface, allowing the barrier shoreline landforms to migrate landward in response to storms, waves, and currents. Subtidal sediment placement met all five of the initial screening criteria and was carried forward for further consideration.

Addition of Sediment into Nearshore Environment

Addition of sediment to the nearshore environment met all five of the initial screening criteria and was carried forward for further consideration. This measure involves the placement of sediment in the gulf intertidal habitat from the gulf side beach slope to shallow open water. The environmental benefits of this measure are similar to the previous two elements in that it will restore the intertidal portion of the shoreface, widen the geomorphic structure of the island, and increase the sediment available for longshore transport, which could benefit adjacent barrier shoreline.

Breach Closure

Breach closure met all five of the initial screening criteria and was carried forward for further consideration.

Small Marsh Island Construction on Bayside

Marsh island construction met all five of the initial screening criteria and was carried forward for further consideration. This restoration measure would provide environmental benefits by creating habitat for sea birds and wading birds and to strengthen the overall island complex without destroying existing vegetations.

Vegetation Planting

Vegetation planting met all five of the initial screening criteria and was carried forward for further consideration. Vegetation plantings are a common component of barrier island dune and marsh restoration projects and are often installed to stabilize dredged material and supplement natural colonization.

Herbivory Control

Herbivory control met all five of the initial screening criteria and was carried forward for further consideration. Herbivory control measures (nutria excluders, trapping, and hunting) may be used in conjunction with other measures to increase the likelihood of project success especially in areas of high nutria populations.

Bio-engineered Oyster Reefs

Bio-engineered oyster reefs are currently being evaluated as a CWPPRA demonstration project (LA09) to determine their effectiveness at reducing shoreline retreat. No published reports were available that indicated bio-engineered oyster reefs would achieve the goals and objectives of the Study. Therefore they were eliminated from further consideration. However, the measure may be reconsidered in preconstruction, engineering, and design (PED) if the CWPPRA demonstration project proves that they are effective.

Spit Creation

Spit creation met all five of the initial screening criteria and was carried forward for further consideration. This measure involves using dredged material to construct a linear beach extending from a headland.

Backfilling Canals

Backfilling canals involves placing sediment in oil and gas access canals. The measure met all five of the initial screening criteria and was carried forward for further consideration. Backfilling canals would increase beach, dune, and marsh habitat, restore natural hydrology and barrier island rollover capacity, and improve the structural integrity of the island.

3.2.3.1.3 Results

Qualitative screening of 31 measures (19 hard-structural and 12 soft-structural) proposed in the initial array resulted in the elimination of 15 measures and the retention of 16 measures to be carried forward for more detailed evaluation in the second level of screening. These management measures were determined to be consistent with specific USACE policies for ecosystem restoration, and Federal laws, regulations, and Executive Orders. The measures that were carried forward include the following:

- Segmented Breakwaters
- Continuous Revetments (Wine Island Only)
- Terminal Groin
- Sand Fencing
- Canal Plugs
- Dune Restoration
- Marsh Creation
- Beach Restoration
- Subtidal Sediment Placement
- Addition of Sediment into Nearshore Environment
- Breach Closure
- Small Marsh Island Construction on Bayside
- Vegetative Planting
- Herbivory Control
- Spit Creation
- Backfilling Canals

3.2.3.2 Second Level Screening

The second level screening effort built on the initial screening process, with an emphasis on the combinations of measures that could be used to meet the specific objectives of the Study. Combinations of management measures are referred to as "island strategies." This screening process was undertaken during a three-day field trip to the islands (27 to 30 July 2009), involving 20 members of the PDT, representing the responsible State and Federal agencies and the SJB/CEC team. Results of the previous screenings were reviewed in situ, along with observations of the conditions of past CWPPRA and CIAP projects. The days' observations were reviewed, reinforced, and recapitulated during evening discussions, to ensure this consensus. Based on these discussions, it was determined that no stand-alone measure would achieve Study objectives. Furthermore, it was the consensus of the team that the primary island strategy should be a combination of beach, dune, and marsh restoration measures. These measures, when used in combination, were the only management measures capable of meeting the primary objective of restoring the geomorphologic form and ecologic function of the barrier islands. A detailed discussion of the development of this island strategy is provided in Section 3.3.2.

Secondary soft-structural measures, such as stand-alone marsh construction, breach closure, and miscellaneous sand placement were eliminated for further consideration because the combination beach, dune, and marsh island strategy would provide similar, but greater benefits. More importantly, these soft-structural measures could not meet the objectives of the Study as stand-alone measures or in combination with any other measure.

Sand fences, vegetative planting, herbivory control, segmented breakwaters, terminal groins, and continuous revetments remained in the evaluation based on their potential to provide supplemental benefits to the beach/dune/marsh island strategy proposed above.

The measures that were carried forward include the following:

- Segmented Breakwaters
- Continuous Revetments (Wine Island only)
- Terminal Groin
- Sand Fencing
- Dune Restoration
- Marsh Creation
- Beach Restoration
- Vegetative Planting
- Herbivory Control

Table 3-1 summarizes the management measures that were screened in the initial and second levels of screening. The table also provides rationales for their elimination.

Table 3-1: Management measures removed from further consideration

Management Measure Removed	Decision Rationale
	Hard-Structural Measures
• Continuous Breakwaters (Specific Location) • Segmented Breakwaters (Entire Island) • Continuous Breakwaters (Entire Island) • Segmented Revetments (Specific Location) • Segmented Revetments (Entire Island) • Segmented Sheet pile (Specific Location) • Continuous Sheet pile (Specific Location) • Segmented Sheet pile (Entire Island) • Segmented Sheet pile (Entire Island) • Continuous Sheet pile (Entire Island)	These measures were eliminated because of the potential environmental impacts (interference with endangered sea turtle nesting and hatchling survival, interference with endangered shore bird foraging) and the inability of these measures to meet the planning objectives of the Study. These structures interfere with the normal longshore and cross-shore movement of sediment in the coastal system. They introduce a systemic disruption into the barrier island shoreline processes, one that will likely be beneficial in some situations and detrimental in others. While they may be effective in certain local applications, they may result in increased erosion elsewhere in the system. The Wine Island "revetment" is actually a containment dike into which dredge spoil has been pumped. The revetments on East Timbalier Island have failed to stabilize the shoreline, which continues to migrate north, away from the rocks.
• Shoreline Groin	Shoreline groins were eliminated based on a lack of efficiency. During near-normal wave incidences (i.e. during typical storm events), a shoreline groin system can create strong local currents and rip currents which can contribute to the offshore movement of beach materials (USACE, 2008b).
• Sunken Barges/ships • Floating Barges/ships	Barges/ships were eliminated because of environmental impacts and engineering feasibility. Potential for hazardous materials releases, the need for extensive dredging, and other similar issues. Difficulty in securing vessels and ensuring that they will stay in place during storms. These vessels could cause significant damage to oil and gas facilities if they were to break loose.
• Pass Closures	Pass Closures were eliminated because of lack of efficiency and ability to achieve the planning objectives. Closing passes is not feasible because hydrodynamics dictate that plugging one pass will result in the volume of water being shifted either to another pass or through newly-created breaches.
• Canal Plugs	Canal plugs were eliminated because they are unable to achieve the planning objectives of the Study as stand-alone measures. The beach, dune, and marsh creation measures were designed to fill the existing canals, thus, eliminating the need to install plugs. Therefore, plugs could not be used as supplementary measures.

Management Measure Removed	Decision Rationale
	Soft-Structural Measures
• Subtidal Sediment Placement	Subtidal sediment placement was eliminated because it would not achieve the planning objectives of the Study if done as a stand-alone measure. Furthermore, construction of the beach, dune, and marsh components would incidentally result in subtidal sediment placement. Therefore, subtidal sediment placement would not provide any additional benefit as a supplemental measure.
• Addition of sediment into Nearshore Environment	Addition of sediment into nearshore environment was eliminated because it would not achieve the planning objectives of the Study if done as a stand-alone project. Furthermore, the beach, dune, and marsh creation measures were designed to place sediment in the nearshore environment. Therefore, nearshore sediment placement would not provide any additional benefit as a supplemental measure.
• Breach Closures	Breach closures would not achieve the planning objectives of the Study as stand-alone measures. Furthermore, beach, dune, and marsh creation will result in the filling of existing breaches. Therefore, breach closures would not provide any additional benefit as a supplemental measure.
• Small Marsh Island Bird Habitat	Small march island creation would not achieve the planning objectives of the Study as a stand-alone measure. Furthermore, the creation of a back-barrier marsh will result in bird habitat creation. Therefore, small marsh island creation would not provide any additional benefits as a supplemental measure.
• Bio-engineered Oyster Reefs	Bio-engineered oyster reefs are currently being evaluated as a CWPPRA demonstration project (LA08) to determine their effectiveness at reducing shoreline retreat. No published reports were available that indicated bio-engineered oyster reefs would achieve the planning objectives of the Study.
• Spit Creation	Spit creation would not achieve the objectives of the Study as a stand-alone measure. Furthermore, the creation of beach would provide similar benefits as spit creation. Therefore, it would not provide any additional benefit as a supplemental measure.
• Backfilling Canals	Backfilling canals will not achieve the objectives of the Study as stand-alone measures. Beach, dune, and marsh creation will result in the backfilling of canals. Therefore, backfilling canals will not provide any additional benefit as a supplemental measure.

3.2.3.3 Final Screening

At this point in the screening process, the PDT had concluded that the island strategies must include a beach, dune, and marsh component in order to achieve the objectives of the Study. Therefore, the final screening effort, which built upon the second level screening process, evaluated the use of supplementary measures including sand fences, vegetative planning, herbivory control, breakwaters, terminal groins, and continuous revetments (for Wine Island Only). The following sections discuss the applicability of various combinations of these measures as they relate to each island.

3.2.3.3.1 Raccoon Island

As part of CWPPRA project TE-29, eight detached segmented breakwaters were constructed in 1997 at the eastern end of Raccoon Island to reduce shoreline erosion and promote accretion.

Louisiana State University (LSU) Coastal Studies Institute quantified the effects of the breakwaters through the analysis of wave data and topographic and bathymetric surveys. The data derived from wave gauge deployments in October 1997, March 1998, and July 1998 indicated that the breakwaters reduced incident wave heights by 90% landward of the breakwaters and by 0% in the gaps between the breakwaters. The breakwaters reduced shore-oblique wave heights by 70% landward of the breakwaters and 50% in the gaps (LDNR 1999).

Topographic and bathymetric data indicate that salients developed rapidly along the shoreline and sediment began to accumulate leeward of six of the eight breakwaters during the first year of monitoring. Shoreline retreat occurred at all transects located in gaps between breakwaters but at a rate 10% lower than the long-term shoreline retreat rate which indicates that the breakwaters were providing some protection to the beach (Figure 3-1). Shoreline retreat rates were highest east and west of the breakwater system. The transects to the west of the breakwaters retreated at a rate of 29.7 ft/yr which is 26% greater than the long-term average of 23.6 ft/yr but less than the short-term average of 58.1 ft/yr. The eastern end of the Study Area eroded more than 69 ft/yr during the first twelve months of monitoring (LDNR 1999).

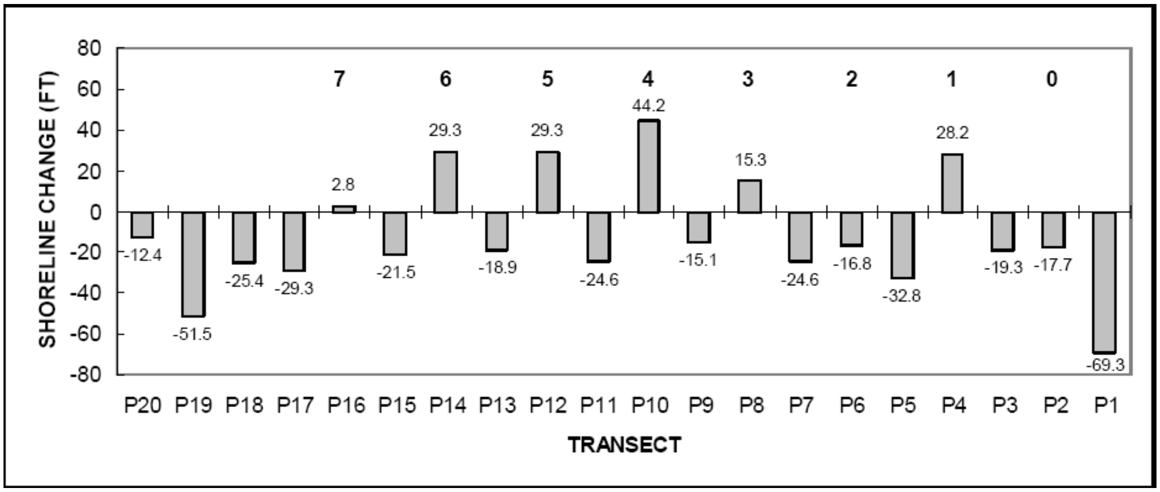

Figure 3-1. Shoreline changes along the TE-29 Study Area from April 1997 to April 1998. The bold numbers above the bars indicate the location of the eight segmented breakwaters with respect to the individual transects (LDNR 1999).

Volume changes between the dune and the breakwaters during the first year of monitoring are presented in Figure 3-2. Increases in volume occurred along all transects except for the four transects west of the breakwater field (P17 through P20), P2, and P5 (LDNR 1999).

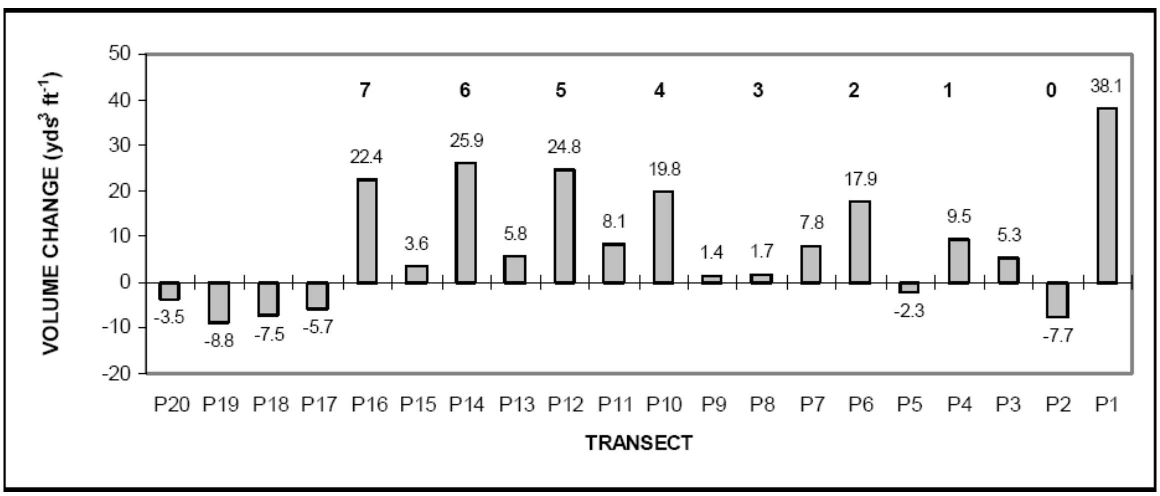

Figure 3-2. Volume change of individual transects along the TE-29 Study Area during the first year of monitoring. Bold numbers above the bars indicate the location of the segmented breakwaters with respect to the individual transects (LDNR 1999).

In 2005, eight additional breakwaters were constructed immediately west of the original eight structures (Project TE-48) (Figure 3-3). The breakwaters have been effective in holding sand on the eastern portion of the island, while the western portion has continued to erode. Partial healing of this damage has taken place following passage of the storms, facilitated by normal longshore sediment transport from the eastern part of the island (Figure 3-4). The source of this material has been postulated to come from a large shoal that lies offshore of the eastern breakwater field (Stone, et al., 2003). The apparent success of the breakwater field at Raccoon Island led to suggestions that breakwaters should be seriously considered elsewhere on the island.

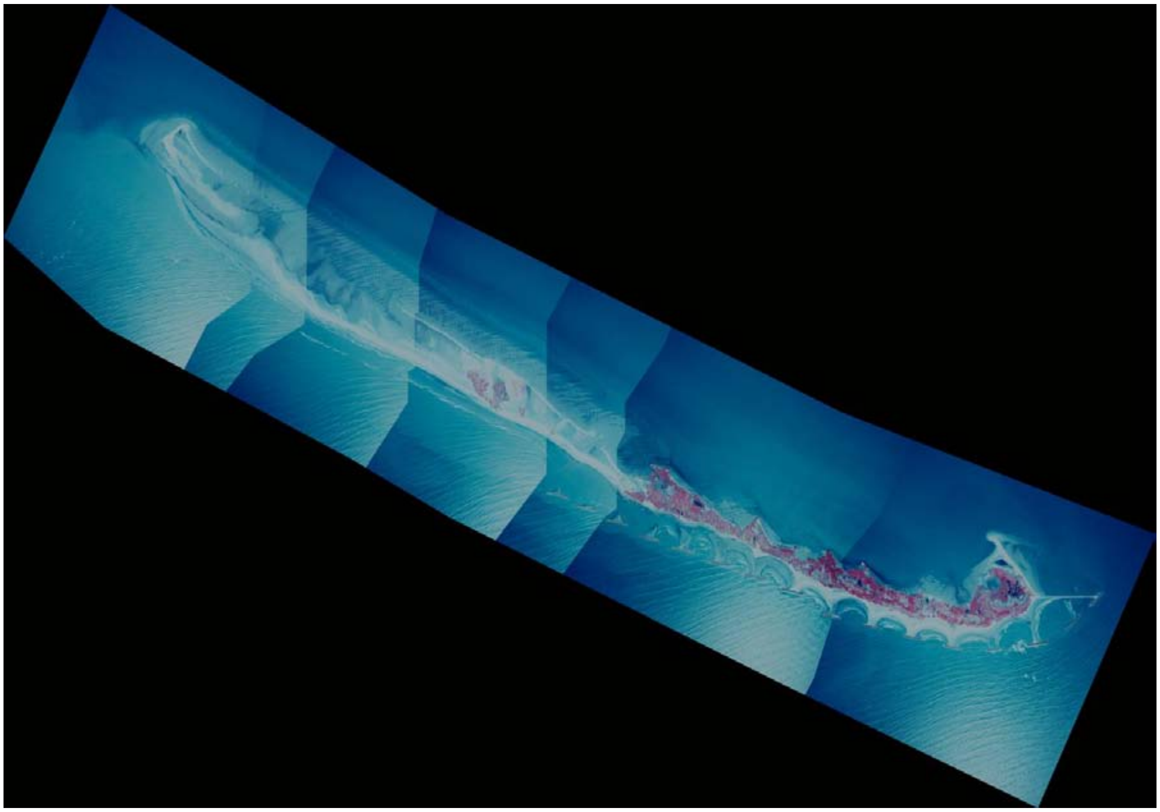

Figure 3-3. Raccoon Island in 2007 following construction of second set of breakwaters. (Photograph provided by NRCS).

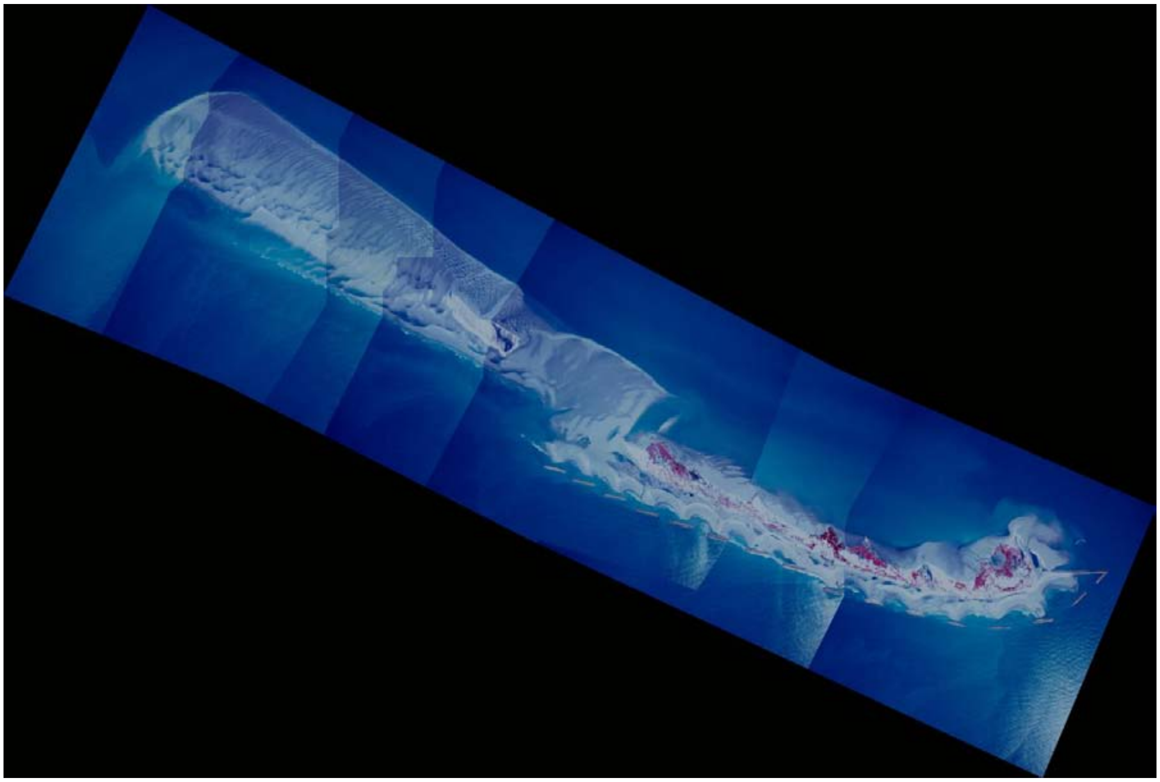

Figure 3-4. Aerial photograph of Raccoon Island taken in November 2008 following Hurricanes Gustav and Ike (Photograph provided by NRCS).

The PDT evaluated the potential effectiveness of an additional series of breakwaters and a terminal groin on the western end of the existing breakwater field using a series of models. The Steady State Spectral Wave (STWAVE) was used to transform wave data from offshore locations to the surf zone. This information was used in the Generalized Model for Simulating Shoreline Change (GENESIS) to evaluate the impact of the structures on shoreline erosion. The coupled STWAVE/GENESIS model was calibrated for Raccoon Island for a period preceding the initial construction of the breakwaters and for the period following breakwater construction.

The model platform was first used to assess the effectiveness of a 1,200-ft long terminal groin at the western end of the island. A separate analysis was conducted to assess the effectiveness of eight 300-ft long detached breakwaters along the remaining western shoreline of the island. This analysis utilized the results of the GENESIS modeling simulations of the existing breakwaters to extrapolate the effects of the eight proposed breakwaters. A detailed discussion of the model efforts is provided in the annex of Appendix L.

Based on the results of the two simulations, both series of structures are expected to reduce shoreline erosion rates on the island. Furthermore, a preliminary cost-benefit analysis shows that the island strategy would be more cost-effective (i.e. have a lower cost/acre) if it includes a terminal groin or additional breakwaters (Table 3-2).

Table 3-2: Cost-Benefit Analysis of Raccoon Island

Island Strategy[a]	Project Cost	Acres	Cost/ Acre
Raccoon Island	$54,400,000	301	$181, 000
Raccoon Island w/ Additional Breakwaters	$58,100,000	326	$178,000
Raccoon Island w/ Terminal Groin	$56,600,000	324	$175,000

[a]The three island strategies include a beach, dune, and marsh component

Raccoon Island is the western-most island in the Isles Dernieres reach, with nothing but open water to the west. The closest land is Pelican Island and Point au Fer Island, 10 miles to the northwest across a complex of shoals east of the mouth of Bayou du Large. These shoals and the large offshore sand body to the south of the Isles Dernieres (Ship Shoal) receive large amounts of fine sediment (silt and clay) from the outflow of the Atchafalaya River. This contribution is dependent on tropical cyclone activity and winter storm cold front passage, with the latter occurring almost weekly during the winter months. The fair weather dispersal pattern for this sediment is to the west, towards the Cheniere Plain coast and Texas. However, the aforementioned events re-suspend the fluvial sediment and re-direct the river discharge onto the adjacent shelf to the south and east.

Measured sediment discharge from the Atchafalaya at Morgan City and the Wax Lake Outlet varied from near zero to as much as 280 and 130 tons per day, respectively. At peak (spring) flows the two sites recorded discharge rates of 300,000 and 200,000 cubic ft per second, respectively (Stone, *et al*., 2009). The same authors indicate that surface sediment samples from Ship Shoal, 50 km southeast of the Atchafalaya outlets, show accumulation of fluid mud. *In situ* instrumentation and satellite imagery show "…that fluvial fine sediments debouched from the Atchafalaya River, in a form of fluid mud, were accumulated onto the shoal in the wake of storms" (*ibid*., p. 90). The sediment that moves off of Raccoon Island to the west is simply lost to the shoals and perhaps buried by the mud stream from the Atchafalaya, so a terminal groin on Raccoon Island will not starve an island in an adjacent reach.

LDWF values Raccoon Island very highly because it is the largest pelican rookery in Louisiana, is critical habitat for piping plover, and is frequented by other threatened and endangered species. The proposed conceptual restoration footprint (beach, dune, and marsh) was shown covering some existing island habitat. The PDT concluded that the footprint should be shifted gulfward and reconfigured to avoid the existing marsh and rookery. In addition, sand should be placed between the breakwaters and the beach to act as a feeder for the downdrift beach.

The measures that were carried forward for Raccoon Island include segmented breakwaters, a terminal groin at the west end of the island (to retard sand loss into Caillou Bay), dune restoration, marsh creation, beach restoration, sand fencing, vegetative plantings, and herbivory control. Sand fencing was considered to be a necessary accompaniment to any beach and dune restoration effort. It was obvious, from observations, that the most effective fencing installations were multiple rows, oriented parallel to the shoreline.

3.2.3.3.2 Whiskey Island

Caillou Boca, which is a deep channel between Whiskey Island and the mainland, presents a unique challenge for the restoration efforts. The channel will prevent island roll-over because overwashed sediments will be carried away by the channel and will be lost from the system. This will make it difficult to maintain the width of the island's marsh component. Since the island is considered a valuable wildlife habitat (Isles Dernieres Barrier Islands Wildlife Refuge) and the LDWF is reestablishing a pelican rookery on the island, maintaining adequate areas of healthy beach, dune, and marsh is particularly important. The PDT concluded that the restoration template should be positioned to avoid the existing marsh and the associated mangrove stands to protect existing sensitive habitats.

CWPPRA project TE50 (Whiskey Island Back Barrier Marsh Creation) was completed in September 2009. The LDWF is interested in protecting the new marsh with a combination of beach and dune restoration and construction of a field of segmented breakwaters, similar to those on Raccoon Island. Based on this input, the PDT undertook a modeling effort to determine the efficacy of a segmented breakwater field in protecting the beach that fronts the marsh area.

In conjunction with the GENESIS modeling effort used to assess the breakwaters and terminal groin on Raccoon Island, the effectiveness of segmented breakwaters placed off Whiskey Island was evaluated (Appendix L). The modeling results indicated that the rate of shoreline erosion would be reduced by the structures. However, a preliminary cost-benefit analysis indicated that the additional benefits provided by the breakwaters could not be justified by the additional costs associated with their construction (Table 3-3). Since the breakwaters considerably increased the cost/acre, they were eliminated as a possible measure for Whiskey Island. Terminal groins were also eliminated because they could potentially cutoff sediment supply to Raccoon Island.

Table 3-3: Cost-Benefit Analysis of Whiskey Island

Island Strategy[a]	Project Cost	Acres	Cost/Acre
Whiskey w/out Breakwaters	$63,520,000	474	$134,000
Whiskey w/Breakwaters	$88,300,000	544	$162,000

[a]Both island strategies include a beach, dune, and marsh component

The measures that were carried forward for Whiskey Island include dune restoration, marsh creation, beach restoration, sand fencing, vegetative plantings, and herbivory control.

3.2.3.3.3 Trinity/East Island

East Island had been part of Trinity Island until 1974, when Hurricane Carmen breached the island. Subsequent hurricanes widened the breach, which was named New Cut. East Island has had one CWPPRA project (TE20), involving dune enhancement and marsh creation. The project, Isles Dernieres Restoration East Island, was combined with the preceding project (TE24) and both were completed on the same timetable in 1998, with the revegetation effort concluding in 1999. Littoral drift carried sand from the East Island project into New Cut. In addition, a separate CWPPRA project, TE37, New Cut Dune and Marsh Restoration, was developed to close the breach, and it was completed in 2007. That project created a dune platform that matched the elevation of the adjacent platforms on East and Trinity Islands, thus restoring Trinity Island to a semblance of its original linear dimension.

The PDT concluded that the combination of beach, dune, and marsh restoration was the best mechanism for protecting most of Trinity/East Island, but again emphasized shifting the template Gulfward. The team stressed the importance of marsh creation behind the newly-restored Trinity/East Island, to buffer the north side of the island from wind-driven waves moving across Terrebonne Bay from the north and northeast and help anchor the beach/dune system by providing a marsh platform to hold overwash sand and retain it in the island profile.

Sand fencing has been a structure used at previous projects on Trinity/East Island. Some fences were continuous, shore-parallel installations and some were short sections, sited at 45 degrees to the shoreline alignment. Observation of these reinforced the consensus that sand fencing should be an integral component to all beach/dune projects and that it should be aligned parallel to the shoreline.

The measures that were carried forward for Trinity and East Islands include dune restoration, marsh creation, beach restoration, sand fencing, and vegetative planting. Although there is currently a canal on Trinity Island that would benefit from a plug in the near-term, the restoration of the dune, beach, and marsh will provide a longer-lasting solution. Based on the results of the modeling efforts for Whiskey Island, it was inferred that segmented breakwaters would not be cost-effective on Trinity or East Island and therefore were eliminated from further consideration. Terminal groins were also eliminated because they could potentially cutoff sediment supply to Whiskey and Raccoon Island.

3.2.3.3.4 Wine Island

Historically, Wine Island was the easternmost island of the Isles Dernieres. It was approximately three miles in length, and located across the mouth of the present Wine Island/Cat Island Pass (Penland, et al., 2005). By the mid-20th Century the island had migrated north and slowly disappeared. What is now called Wine Island is a rock-stabilized dredge material disposal site, associated with the Houma Navigation Canal (Channel). The Terrebonne Parish Council has requested restoration of Wine Island in a resolution, adopted on 25 March 2009. It is obvious from the wording of the resolution and previous correspondence from the Parish President that the desire is to reduce the width of the pass by restoring Wine Island to some previous dimension and location. Wine Island is also an active seabird rookery, thus its preservation and improvement is important to LDWF.

The island was once surrounded by a boulder revetment, constructed in 1991 to hold discharged material from dredging the HNC. The island is no longer contained within the revetment. Its area has been reduced and its footprint has migrated north such that about one third of it presently lies outside the subcircular ring of rocks.

The team suggested two courses of action regarding Wine Island. The first involves restoring the island within the boulder revetment, through beneficial use of sediment dredged from the HNC. The second would be a much more ambitious project, involving development of a restoration template anchored at the present island location and extending to the adjacent shoal, referred to locally as the Monkey Bar, to create a larger island, more in accord with the request from Terrebonne Parish.

If the former course of action is followed, the restoration template would overlay the existing subcircular revetment, which would serve as containment for the dredged sediment. The small area of the island precludes attempting differentiation of beach, dune, and marsh. Rather, the fill material would be graded and planted with dune-stabilizing vegetation, to prolong sediment retention and provide additional habitat for the birds.

If the latter course of action is selected, the restoration template would overlay the existing island, the subcircular revetment, and extend to the west to encompass the shoal. Developing the template will be dependent on a modeling effort based on detailed bathymetry of the shoal and selection of a method to contain the fill material. The exposed nature of the shoal appears to preclude use of earthen dikes for containment and, without the foundation of an existing beach and dune system, unconfined pumping of beach sediment appears to be out of reach physically and financially. This situation may change if the sediment source is maintenance dredging and/or realignment of the HNC (Rosati, 2008).

The measures that were carried forward for Wine Island include repair of the existing continuous revetment, dune restoration, marsh creation, beach restoration, sand fencing, vegetative plantings, and herbivory control.

3.2.3.3.5 Timbalier Island

Timbalier Island has had two CWPPRA projects. The first one, TE18, involved installation of sections of sand fencing (greater than a mile in total) in different areas in 1995, and planting dune-stabilizing vegetation in selected areas in 1996. The second project, TE40, offset the ongoing erosion of the east end of the island by restoring more than two miles of beach and dune, installing more sand fencing, planting dune-stabilizing vegetation, and building additional marsh. A second component of TE40 was the addition of sediment to the nearshore to facilitate longshore transport without eroding the restored beach.

The large breach on Timbalier Island presents a compelling argument in favor of canal backfilling. There is sufficient tidal exchange occurring through the canal to prevent sediment accumulation. Therefore, the PDT concluded that the proposed restoration template, combining beach, dune, and marsh creation, was the best overall solution to restoring Timbalier Island. To be effective, it must include closure of the existing breach as well as backfilling as many of the canals as possible. This latter activity may be difficult, because the canals are apparently routinely used to service isolated petroleum production facilities and wells, based on evidence of recent dredging. The PDT noted the elevation of the dune field created by CWPPRA project TE-40, and recommended that new dune construction match it. It was also noted that the eastern third of the TE-40 project's dune fencing is now offshore, indicating that the east end of the island has continued to erode. The proposed restoration template includes restoration of that part of the island.

The measures that were carried forward for Timbalier Island include dune restoration, marsh creation, beach restoration, sand fencing, vegetative plantings, and herbivory control. Based on the results of the modeling efforts for Whiskey Island, it was inferred that segmented breakwaters would not be cost-effective on Timbalier Island and therefore were eliminated from further consideration.

During field visits to Timbalier Island, the PDT observed evidence of sediment accumulation at the western end of the island. Therefore, it was determined that a terminal groin would not be needed on the island.

3.2.3.3.6 East Timbalier Island

East Timbalier Island is the site of an oil and gas production and processing facility. Much of the island was in imminent danger of disappearing when its two CWPPRA projects were implemented. The projects are East Timbalier Island Sediment Restoration, Phases 1 and 2, TE25 and TE30, respectively. The combined projects created a wide beach and dune system, backed by a wide marsh on the western, large portion of the island. The restored areas were vegetated and sand fencing was installed. Unfortunately, the goal of rejoining the two ends of East Timbalier Island was not met. A rock rubble revetment parallels the shoreline of both parts of East Timbalier Island, on the order of 500 to 1,000 ft offshore. The distance indicates the northward movement of the island, in the time since the revetment was placed on the shoreline. Project TE30 also constructed a similar revetment along the beach face to protect the restored beach and dune.

The proposed island restoration template includes the presently submerged eastern half of the island, which was initially proposed as part of the CWPPRA project TE-30, but was not completed. Should the east-west dimension of the island be restored, it was suggested that a terminal groin be installed at the east end of the fill, to prevent it from migrating into Timbalier Bay. However, a terminal groin was later eliminated because of the potential impacts the structure could have on sediment supply to Timbalier Island.
The PDT discussed previous attempts to stabilize East Timbalier Island. Several series of boulder revetments were place on the shoreline in the past. The gulfside rocks are now several hundred ft offshore, and the rock placed along the north shoreline is apparently buried within the island. Due to the lack of effectiveness of the hard structures that have been implemented for past CWPPRA projects, the PDT determined that breakwaters would not an effective measure for East Timbalier and thus eliminated them from future consideration.

The measures that were carried forward for East Timbalier Island include dune restoration, marsh creation, beach restoration, sand fencing, vegetative plantings, and herbivory control.

3.2.3.3.7 Results

Table 3-4 summarizes the island strategies that were carried forward for each island. These island strategies will be combined and paired with various combinations of borrow areas to form alternatives.

Table 3-4: Summary of potential island strategies[a]

Description of Island Strategy	Raccoon	Whiskey	Trinity	East	Wine	Timbalier	East Timbalier
Beach / Dune / Marsh[b]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Beach / Dune / Marsh w/ Segmented Breakwaters[b]	Yes	No	No	No	No	No	No
Beach / Dune / Marsh w/ Terminal Groin[b]	Yes	No	No	No	No	No	No
Marsh Creation w/ Continuous Revetment[c]	No	No	No	No	Yes	No	No

[a] "Yes" indicates the island strategy was carried forward; "No" indicates the island strategy was screened out

[b] Combination includes sand fencing, vegetation planting, and herbivory control

[c] Combination includes vegetation planting and herbivory control

3.2.4 Value Engineering Analysis

In May 2009, Value Management Strategies (VMS) conducted a Value Engineering (VE) analysis. The results of the analysis were summarized in a VE report (VMS, 2009). The VE study included an evaluation of not only the LCA TBBSR Study, but also the Houma Navigation Lock Operations Plan and Convey Atchafalaya River Water to Northern Terrebonne Marshes studies. Specific to LCA TBBSR Study, forty-five ideas were put forth, with 17 designated as "Alternative Concepts," and nine of those identified as "Key Recommendations."

Six key VE-recommended concepts involved soft-structural solutions. One was directly applicable and it had already been incorporated into plan formulation: consider coastal geomorphic processes for sediment placement. Such consideration is common practice in barrier island restoration design. A coastal processes analysis was conducted to define the minimum island dimensions to restore the geomorphologic form and ecologic function of a barrier island. This analysis accounted for both longshore and cross shore sediment transport.

A second key VE-concept involved recycling sand from the downdrift/down gradient end of an island to the updrift end. Recognition of the sand-starved status of Coastal Louisiana resulted in development of a hydrogeomorphic planning objective of the LCA 2004 Report, specifically to import sediment from sources outside of the estuarine basins (i.e., beyond the depth of closure) (LCA, 2004). Therefore the borrow areas for island restoration shall be located seaward of the depth of closure defined as the offshore extent of the active beach face. This second concept is not consistent with this planning objective.

A third key VE-concept called for excavation of a series of inverted breakwaters (shore-parallel pits that reduce wave energy as waves pass across them). Sediment inshore of the depth of closure must be considered as part of the sand budget for that particular reach, and conservation of that resource is essential in a sand-starved system, such as the Louisiana coast. Excavations inshore of the depth of closure have the potential to become sinks that accumulate sediment that is normally part of the longshore or cross shore transport system. Of concern with this concept is conservation of the sand resources and avoidance of interference with coastal processes from excavating these resources for island restoration.

Two other VE-concepts involved hard structures, one a permanent dredge discharge pipe from Ship Shoal to East Timbalier Island and the other installation of a sand-filled geotextile tube or a boulder core beneath the dune, to fix an island in position. Alternative measures similar to these concepts were considered such as continuous rock revetments; however, these measures were screened out in the initial screening as not meeting the planning criteria (Section 3.2.3.1).

The sixth VE-concept was to abandon the existing islands and construct a new island reach to the north. This concept is inconsistent with the LCA 2004 Report that defined the Study as restoring the Terrebonne Basin barrier islands through simulating historical conditions by enlarging the barrier islands (width and dune crest) and reducing the current number of breaches. Further it is inconsistent with the planning objectives developed for the Study (Section 2.3).

The remaining three key VE-concepts were policy suggestions beyond the scope of this Study: establishment of a permanent trust fund for island renourishment, define the Study in terms of sustainability in year 2100, and task the Mineral Management Service with deciding on offshore sediment allocations and locating new, untapped sources of fill material.

3.2.5 Screening / Evaluation of Borrow Areas

Khalil et al. (2010) mapped numerous potential sediment borrow areas along the Louisiana Gulf coast, from South Pass west to Sabine Pass. Six large-volume areas were delineated off the Terrebonne Basin Barrier Islands (Figure 3-5). Three of these are on the Outer Continental Shelf (OCS) and three are in State waters, closer to shore. The latter included a group of five small borrow areas associated with a Timbalier Island project, three north of the island, in the bay, and two to the south.

The borrow area map developed by Khalil et al. (2010) was used as a starting point for the PDT's borrow area search effort. Their tabular compilation included the location of the borrow area, estimated volume of available fill material, volume of material already dredged from the borrow area, and pertinent geotechnical and geophysical references.

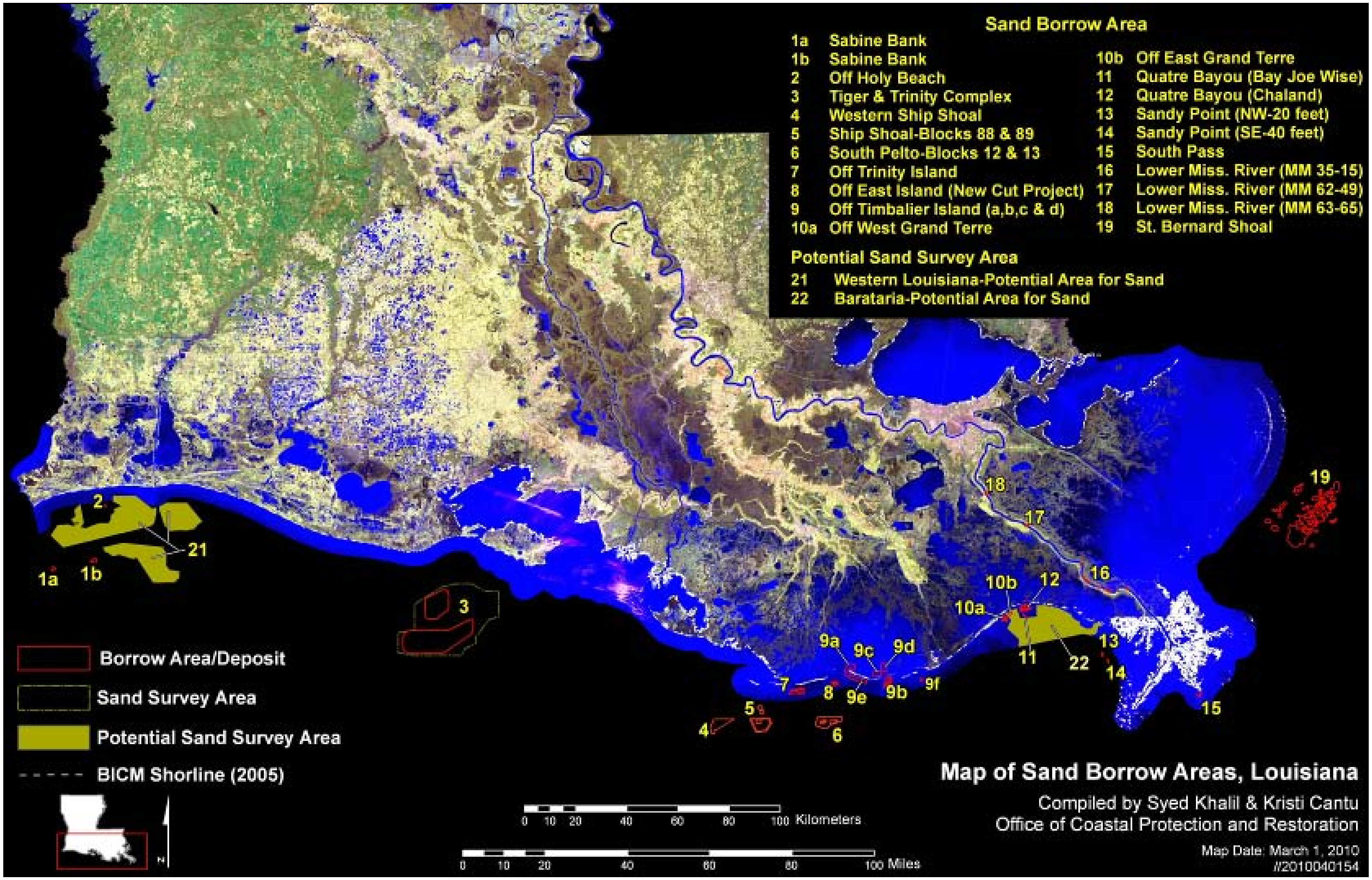

Figure 3-5. Terrebonne Basin borrow areas (Khalil et al., 2010)

3.2.5.1 Borrow Area Characteristics and Screening Criteria

The PDT used a combination of physical, geographic, and socioeconomic characteristics to evaluate the borrow areas presented in Figure 3-5. The primary criterion that was considered in the evaluation is discussed below.

3.2.5.1.1 Location Relative to Depth of Closure

The depth of closure represents the offshore extent of the active beach face, thus sediment inshore of it must be considered as part of the sand budget for that particular reach, and conservation of that resource is essential in a sand-starved system, such as the Louisiana coast. Excavations inshore of the depth of closure become sinks that accumulate sediment that is normally part of the longshore/on-off-shore transport system. Of concern here is conservation of the sand resources and avoidance of interference with coastal processes from excavating these resources for island restoration. Recognition of the sand-starved status of Coastal Louisiana resulted in development of a hydrogeomorphic planning objective of the LCA 2004 Report, specifically to import sediment from sources outside of the estuarine basins (i.e., beyond the depth of closure) (LCA, 2004). Therefore the borrow areas shall be located seaward of the depth of closure which was defined to be equal to -10.5 ft NAVD 88.

3.2.5.1.2 Borrow Area Geotechnical and Geophysical Data

The sediment particle size ranges and distributions should match the characteristic of the beach and dune where it will be placed. In the case of marsh material, there should be variability in particle size to match the existing marsh environment. The sediment should be compatible with the sediment at the fill placement site to avoid accelerated loss of sand and changes in beach face morphology. To maximize efficiency of the excavation process, the core data and seismic profiles should indicate adequate stratum thickness for efficient mining. If the strata are too thin, the excavation process can create a blend of material that may be compatible with the native sediment at the fill placement site, but that must be determined from the data, and not left to chance.

3.2.5.1.3 Borrow Area Volumes

The sediment volume must equal or exceed the estimate of volume needed to complete the Study.

3.2.5.1.4 Cultural Resources/Petroleum Infrastructure Clearance

Cultural resources can be significant constraints. The locations of potential sites, possibly representing either historic shipwrecks or prehistoric sites, and pipelines must be avoided. Remote-sensing surveys are a requisite for consultation with the State Historic Preservation Office (SHPO) and other involved agencies. Use of borrow areas must often be approved or cleared by the Minerals Management Service (MMS) or the LDNR.

3.2.5.1.5 Technical Difficulty

Borrow site location factors, such as water depth and distance to disposal site, can dictate use of hopper or cutterhead dredge. Depending on the alternative, different measures are required to transfer the dredged material to the disposal site(s). The issue involves double handling of dredged material. If the disposal site depth is inadequate to accommodate the draft of a hopper dredge it may require offshore dumping and re-dredging by cutterhead or offshore booster pumps to move material ashore. Inadequate depth at the borrow area to accommodate a hopper dredge may require use of a cutterhead dredge. The latter type is less seaworthy than the former, thus introducing heightened concern about weather-related production interruptions.

3.2.5.1.6 Navigational Features

The HNC, its channel across Terrebonne Bay, and the Bayou Grand Caillou Safety Fairway are Federally-designated waterways in which interference with navigation is an issue. Constraining use of such channels with fill material, structures, or equipment, even temporarily, requires advance notice and authorization from the USACE.

3.2.5.1.7 Mining Impacts

Offshore shoals, bypassing bars, and similar bodies interact with the waves that pass across them. Waves can be attenuated and their directions changed, so that the wave energy that impacts a nearby shoreline is changed. Depending on the wave length, height, and direction, the changes can be beneficial or detrimental, resulting in either accretion or erosion of the shoreline. The results of wave refraction modeling, based on wind and wave direction and intensity data, must be carefully analyzed to ensure that excavation of the borrow area does not result in detrimental changes to the shoreline or nearby passes.

3.2.5.2 Initial Screening

The first-level screening was finalized during the PDT meeting on 11 August 2009. The PDT Team had previous discussions with CPRA staff regarding potential borrow areas and their supporting information, and this was incorporated into the screening process. The first-level screening criterion that was applied to the borrow areas identified in Figure 3-5 was location. Using this criterion, the Timbalier Island Dune and Marsh Restoration (TE-40) borrow areas 9a through 9d were eliminated because all four fell within the depth of closure. Note that Borrow Area 9e was retained.

Table 3-5 presents information about the potential borrow areas that passed the first level of screening. The locations of the borrow areas are depicted in Figure 3-6. It should be noted that the numbers assigned to each area differ from those presented in the Figure 3-5 because several previously unnumbered areas were identified and added to the evaluation.

Table 3-5: First level borrow area screening

ID	Location	Sediment Type	Applicability	Thickness of Sediment Source (ft)	Sediment Composition	Available Volume (mcy)	Cultural Resources
1	Whiskey Island TE-50 Area 1	Mixed, silt, clay (overburden)	Marsh	NA	NA	NA	NA
		Sand	Beach/Dune	0.8 – 2.4	NA	NA	NA
2	Whiskey Island TE-50 Area 2 (subarea 2a)	Mixed, silt, clay (overburden)	Marsh	8-9.5	6-47% sand; 13.5-66.5% Silt; 20.7-83.4% clay	0.29[a]	Chirp. magnetic, and side scan sonar surveys (Ocean Surveys, 2006)
		Sand	Beach/Dune	2.5-7.6	90% sand	0.79[b]	
3	Whiskey Island TE-50 Area 3 (subarea 3a)	Mixed, silt, clay (overburden)	Marsh	3.5-17.4	20% sand; 30-49.7% silt; 27.4-68.7% clay	7.97	Chirp, magnetic, and side scan sonar surveys (Ocean Surveys, 2006)
		Sand	Beach/Dune	2.5-14	80% Sand	4.72	
	Whiskey Island TE-50 Area 3 (subarea 3b)	Mixed, silt, clay (overburden)	Marsh	7.5	6-47% Sand	0.73	NA
		Sand	Beach/Dune	2.7-6.4	80% Sand	1.13	
	Whiskey Island TE-50 Area 3 (subarea 3c)	Mixed, silt, clay (overburden)	Marsh	8	22% Sand	0.18	NA
		Sand	Beach/Dune	8.5	85% Sand	0.20	
4	New Cut TE-37 Area	Sand	Beach/Dune	6	-	2.5[c]	Vibracore & Magnetic Surveys
5	Raccoon Island TE-48	Mixed sand, silt, clay	Marsh	10-20	16.5-24.6% above #200 sieve	2.4[d]	Remote sensing side scan & mag surveys (Goodwin, 2008)
6	South Pelto Blocks 12 & 13	Sand	Beach/Dune	13-20	<5% silt	21.3[e]	Seismic, sonar, and mag surveys (USEPA, 2003b)
7	Ship Shoal Block 88	Sand	Beach/Dune	10-19	<5% silt	17.3	Seismic, sonar, and mag surveys (USEPA, 2003a); Echosounder & vibracore surveys & sediment sampling analysis (STE, 2004)
	Ship Shoal Blocks 84, 85, 98, & 99	Sand	Beach/Dune	8-12	<5% Silt	47.5	Seismic, sonar, and mag surveys (USEPA, 2003a)
8	Western Ship Shoal Blocks 84, 85, 98, &99	Sand	Beach/Dune	13	NA	124[f]	Not Available
9	Cat Island Pass	Sand	Beach/Dune	5-10	Silty sand	6.6[g]	Not Available

[a] Excludes a volume of 2.76 mcy of overburden material estimated for Whiskey Island TE-50 Project

[b] Excludes a volume of 0.36 mcy of dune material estimated for Whiskey Island TE-50 Project
[c] Available volume based upon personal communication with CPRA, Aug 2009
[d] Excludes a volume of 1mcy estimated for Raccoon Island TE-48 Project
[e] Excludes a volume of 7mcy estimated for Caminada Headland Restoration Project
[f] Estimates based on "Results of the Western Ship Shoal Geophysical Survey: Evaluation of Sand Available for Coastal Restoration" Mar 2009
[g] Estimates based on September 2003 geologic profiles obtained from USACE through personal communication

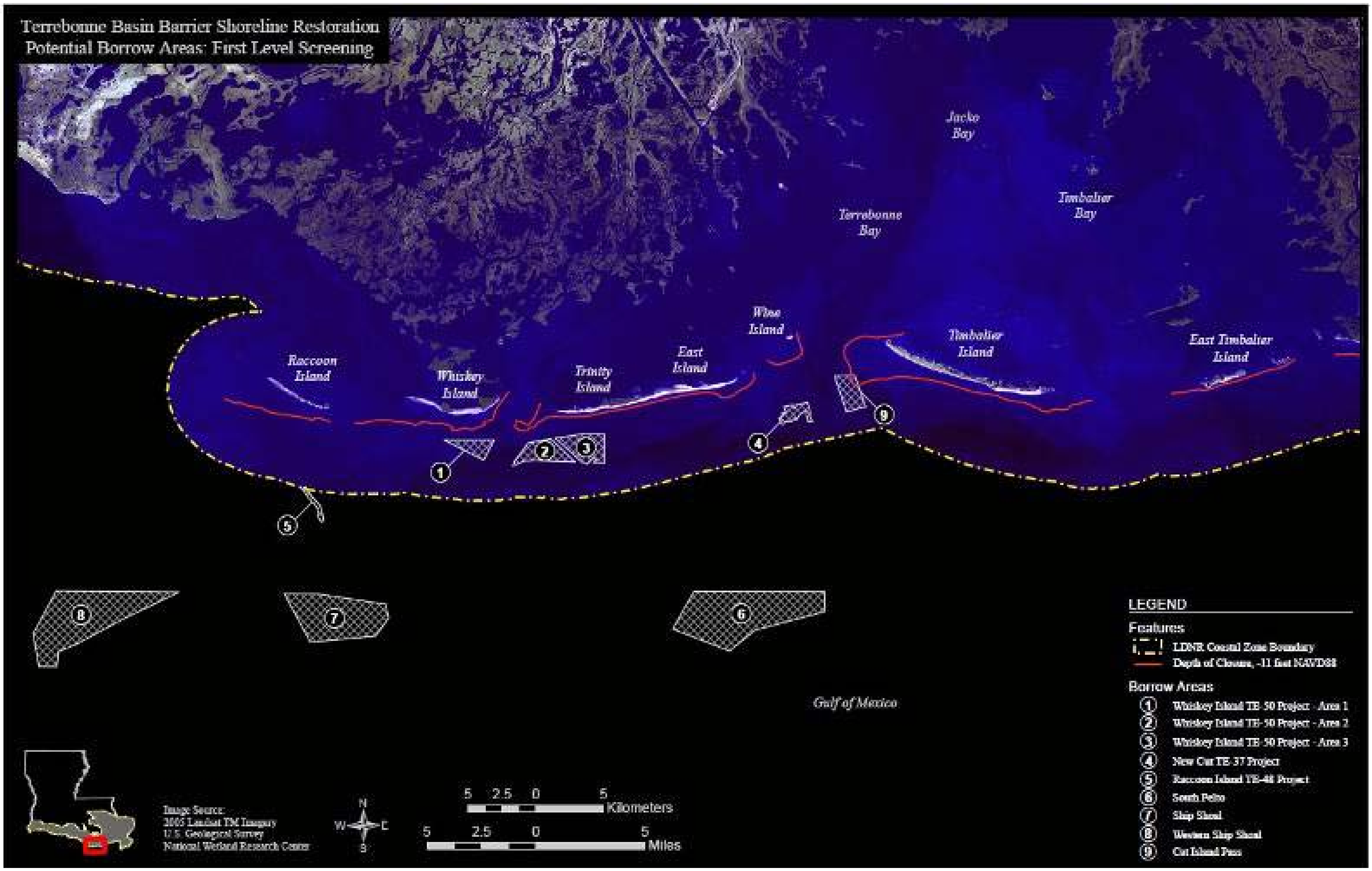

Figure 3-6. First level screening: Borrow area locations

3.2.5.3 Final Screening

The process of screening potential borrow areas continued in September and October 2009, reducing them down to those that provide the requisite volume of sediment, have existing geotechnical and geophysical survey data, and cultural resource data needed to develop conceptual excavation plans. A thorough review of the existing geophysical and geotechnical data indicated that a sufficient volume of compatible sediments was available in the existing borrow areas to construct the LCA TBBSR Study at a feasibility level. Therefore, additional geophysical and/or geotechnical surveys were not conducted during this investigation.

The potential borrow areas that were eliminated during this screening were:

- Timbalier Island TE-40 Borrow Area 9e was eliminated because a portion of it was landward of the depth of closure.
- Western Ship Shoal (Blocks 84, 85, 98, & 99), Borrow Area 4 was eliminated because it lacked detailed geophysical surveys and a cultural resource investigation.
- HNC Channel was eliminated because of the risk and uncertainty of relying on a sediment source that is under the control of interests with a requirement to maintain navigability without undue delay, particularly following storm events that could cause shoaling. Should emergency dredging be required, there would not be sufficient sediment available for construction. In addition, geotechnical and cultural resources data are only available for the portions of the channel that are periodically maintenance-dredged, not necessarily the channel offshore from Cat Island Pass, the logical portion to serve as a borrow area because it is seaward of the depth of closure. There are also restrictions on width of dredge cut, one cannot dredge outside of the designated channel without an Environmental Assessment, and cut depth, one cannot dredge deeper than the authorized channel depth. Taken together, these constraints and restrictions were felt to introduce too much risk to retain the HNC as a viable borrow area. Because of its location, the PDT Team felt that the HNC should be retained as an alternative borrow area to be considered in PED if the cultural resource investigation is completed and the timing of its use is compatible with the navigation interests as determined by USACE.
- Whiskey Island TE-50 Borrow Area 1 was eliminated because it lacked geotechnical and borrow area volume information, detailed geophysical surveys, and a cultural resource investigation.
- Whiskey Island TE-50 Borrow Area 2 was also eliminated as a potential sediment source. During the course of planning for the TE-50 project, T. Baker Smith and Moffatt & Nichol refined the designs of Borrow Areas 2 and 3, designating one subarea in 2 (2a) and three subareas in 3 (3a, 3b, and 3c).

They recommended use of Subarea 2a. Since the TE-50 project has already utilized both the overburden and sand resource volumes in Subarea 2a, Borrow Area 2 was eliminated from further consideration (TBS and M&N, 2007).

- The PDT further refined Whiskey Island TE-50 Area 3. Subareas 3b and 3c were eliminated because detailed geophysical surveys were not conducted and they lacked cultural resource investigations. The Borrow Area 3 outline was reduced to depict only the outline of Subarea 3a, thus Figure 3-7 which presents the final borrow area screening map depicts a smaller Borrow Area 3.

In a similar manner, the outline of the South Pelto borrow area was reduced to represent the actual outline of the combined borrow areas identified in Blocks 12 and 13. Results of the final screening effort are summarized in Table 3-6 and Figure 3-7.

Table 3-6: Final level borrow area screening

ID	Location	Sediment Type	Applicability	Thickness of Sediment Source (ft)	Sediment Composition	Available Volume (mcy)	Cultural Resources Survey Data
3	Whiskey Island TE-50 Area 3 (subarea 3a)	Mixed, silt, clay (overburden)	Marsh	3.5-17.4	20% sand; 30-49.7% silt; 27.4-68.7% clay	7.97	Chirp, magnetic, and side scan sonar surveys (Ocean Surveys, 2006)
		Sand	Beach/Dune	2.5-14	80% Sand	4.72	
4	New Cut TE-37 Area	Sand	Beach/Dune	6	-	2.5[a]	Vibracore & Magnetic Surveys
5	Raccoon Island TE-48	Mixed sand, silt, clay	Marsh	10-20	16.5-24.6% above #200 sieve	2.4[b]	Remote sensing side scan & mag surveys (Goodwin, 2008)
6	South Pelto Blocks 12 & 13	Sand	Beach/Dune	13-20	<5% silt	21.3[c]	Seismic, sonar, and mag surveys (USEPA, 2003b)
7	Ship Shoal Block 88	Sand	Beach/Dune	10-19	<5% silt	17.3	Seismic, sonar, and mag surveys (USEPA, 2003a); Echosounder & vibracore surveys & sediment sampling analysis (STE, 2004)
	Ship Shoal Blocks 84, 85, 98, & 99	Sand	Beach/Dune	8-12	<5% Silt	47.5	Seismic, sonar, and mag surveys (USEPA, 2003a)

a Available volume based upon personal communication with CPRA, Aug 2009
b Excludes a volume of 1mcy estimated for Raccoon Island TE-48 Project
c Excludes a volume of 7mcy estimated for Caminada Headland Restoration Project

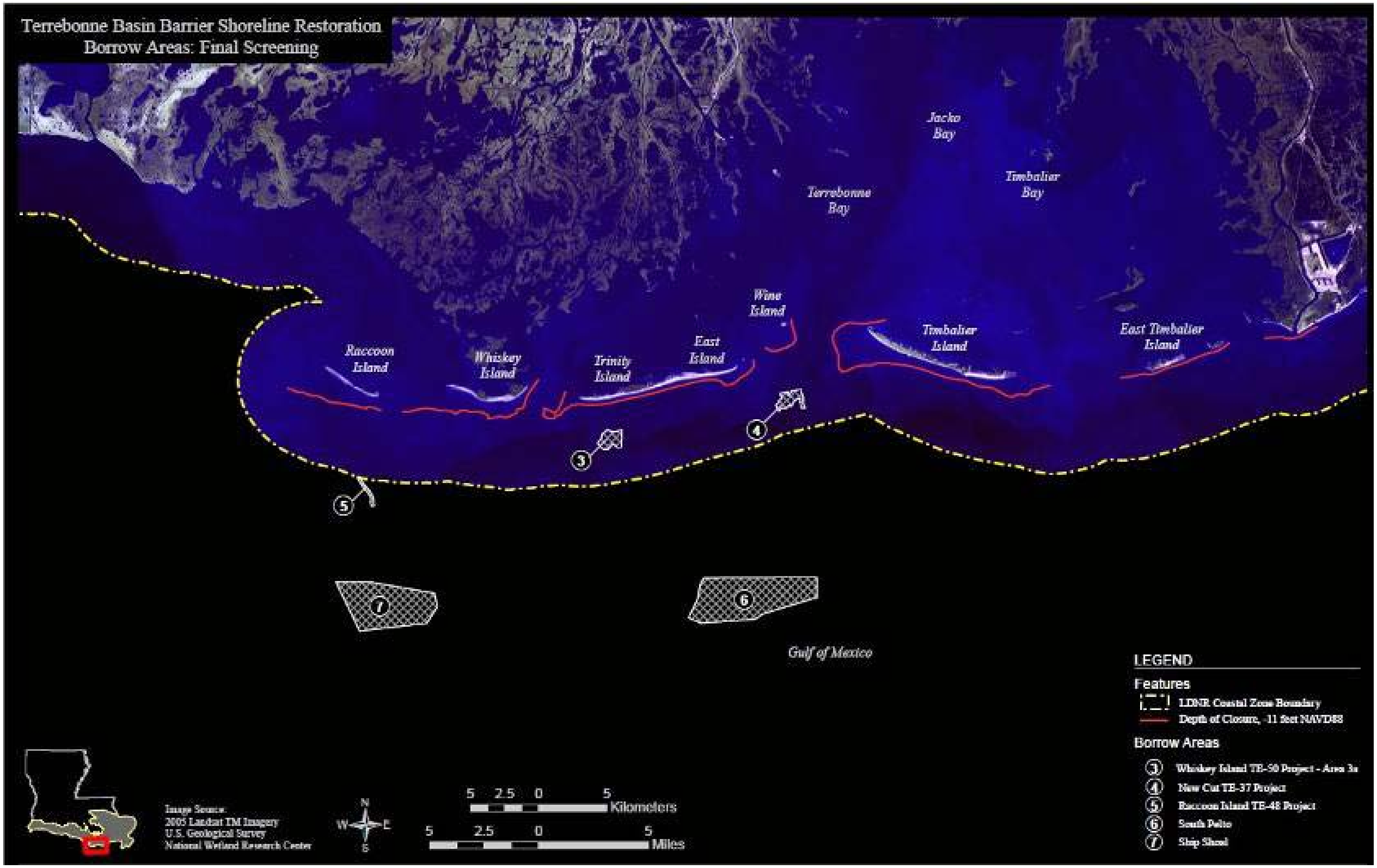

Figure 3-7. Final level screening: Borrow area locations

3.2.5.4 Resulting Borrow Areas

The initially-proposed source of borrow sand for beach and dune restoration was Ship Shoal, an elongate sand body in the Gulf, located 20 to more than 40 miles west of Belle Pass and four to ten miles south of the Isles Dernieres. It is approximately 31 miles long and 7 miles wide, lying in a water depth of 9 to 30 ft. Ship Shoal is ideal for use in restoring the Terrebonne Basin barrier islands since its grain size is equal to or greater than the sand found on the islands. Coarser grain sand is more resistant to erosion. Ship Shoal is the nearest, accessible sand source that contains a sufficient quantity of sand of appropriate quality to match the native sand found on the islands and achieve the Study goals. Screened Borrow Areas 6 and 7 depicted in Figure 3-7 are both located on Ship Shoal. Several closer sand sources, previously identified for other CWPPRA project use, were proffered to the PDT, and they were investigated. The two most-promising are Subarea 3a of the Whiskey Island TE-50 Borrow Area 3 and the New Cut TE-37 Borrow Area 4.
The proposed sources of borrow sediments for marsh creation and restoration have also been identified. Nearshore resources seaward of the depth of closure will be utilized to provide mixed sediments consisting of fine sand, silts, and clays compatible with the existing island framework. The two marsh sediment borrow areas are the Raccoon Island TE-48 Borrow Area 5 and the overburden stratum on Subarea 3a of the Whiskey Island TE-50 Borrow Area 3.

Two previously-considered borrow areas will be revisited during the PED phase of the Study. If there are sufficient time and funding, the geophysical, geotechnical, and cultural resources studies required for Whiskey Island TE-50 Borrow Area 1 will be undertaken. Should the results prove positive the borrow area will be incorporated into the project design. In a like manner, potential beneficial use of sediment from the entrance channel for the Houma Navigation Canal will be explored through the Navigation Branch of the New Orleans District. As described in Section 3.2.5.3, it will be necessary to carry out further cultural resources and geotechnical investigations, but the proximity of the HNC to both Trinity and Timbalier Islands makes it a cost-effective alternative.

3.3 Preliminary Alternative Plans

This section summarizes the development and evaluation of the preliminary alternative plans. For more details on each alternative, refer to the Engineering Appendix, (Appendix L).

3.3.1 Development of Alternative Plans

An alternative is defined as a combination of island strategies and borrow areas. The features that were carried forward from the third level of screening include the following:

- Raccoon Island: Beach/Dune/Marsh

- Raccoon Island: Beach/Dune/Marsh w/ Segmented Breakwaters
- Raccoon Island: Beach/Dune/Marsh w/ Terminal Groin
- Whiskey Island: Beach/Dune/Marsh
- Trinity Island: Beach/Dune/Marsh
- East Island: Beach/Dune/Marsh
- Wine Island: Marsh Creation w/Continuous Revetments
- Timbalier Island: Beach/Dune/Marsh
- East Island: Beach/Dune/Marsh

These island strategies were selected because they would be consistent with the Environmental Operating Principles (EOPs), present the fewest constraints, and would be synergistic with other existing and authorized projects on the islands.

The borrow areas that were carried forward from the third level of screening include the following:

- Whiskey Island TE-50 – Area 3a (marsh material)
- New Cut TE-37 (beach/dune material)
- Raccoon Island TE-48 (marsh material)
- South Pelto (beach/dune material)
- Ship Shoal (beach/dune material)

The above mentioned borrow areas were selected because they were outside the depth of closure, had adequate capacity of compatible material, and included cultural resource survey information.

Initially, each of the island strategies was combined with each of the marsh and beach/dune borrow areas. However, this produced a cumbersome number of alternatives to be analyzed (over 4 million). In an effort to reduce the number of alternatives to a more manageable number, the PDT evaluated the location and capacity of each borrow and paired the most appropriate borrow areas to each measure.

3.3.2 Description of Alternative Plans

Five restoration plans, denoted as Plans A through E, were developed as part of plan formulation. The plans are discussed in the following sections. An additional option was derived for Wine Island that included placing beach compatible sand within the existing rock revetment locally known as the Wine Island Ring. Two additional options were derived for Raccoon Island including the construction of eight additional breakwaters (BW) or construction of a terminal groin (TG).

3.3.2.1 No Action Plan (Plan A) - Future Without Project Conditions

Plan A represents the No Action plan, that is, no sediment is imported to restore the islands components (i.e. beach, dune and marsh) and no restoration actions are taken. The No Action plan is synonymous with Future Without Project (FWOP) conditions. This plan as identified as Alternative 1 in subsequent sections of the report.

3.3.2.2 Minimum Design Plan (Plan B)

The restoration template for Plan B provides for the minimal geomorphologic form and ecologic function on each island and retains this form and function after being subjected to a number of design storms.

3.3.2.2.1 Geomorphologic Form and Ecologic Function

The barrier islands in the Study Area are the remains of an abandoned Mississippi River Delta; and their degradation is the result of anthropogenic activities and episodic storm impacts, in combination with natural deltaic processes. The barrier islands are typically low lying and comprised of three physical features, the beach, dune, and back barrier marsh. They act as a buffer to reduce the full force and effects of wave action, saltwater intrusion, storm surge, and tidal currents on associated estuaries and wetlands. To restore their geomorphologic form and provide this buffer involves reinforcing the shoreline through beach and dune restoration. In addition, it includes providing a marsh platform to capture overwash sediments during episodic events; sediment that would otherwise be carried into back bay areas to form shoals or be lost into deeper waters. The marsh also serves as a roll over platform as the islands migrate landward.

Restoration of ecologic function of the barrier islands includes vegetating both the restored dunes and back barrier marsh platforms with native plants, to provide wetland habitat for a diverse number of plant and animal species and to help retain sediment. This approach is supported by the Wetland Value Assessment (WVA), which has been chosen as the model to evaluate the ecosystem restoration project benefits. The WVA states that the key habitat components, dune, supratidal (beach), and intertidal (marsh), combine to provide the optimum metric by which the islands should be compared (CWPPRA, 2002).

In order to provide geomorphologic form and ecologic function, the beach, dune, and marsh components must exhibit certain dimensions. These dimensions were defined through analysis of historical planforms and elevations. Furthermore, these dimensions must be maintained after being subjected to selected design storms. The design storms that were used in template development included a hypothetical 50-year storm as well as the varying intensities, durations, and approach paths of Hurricanes Katrina and Rita, which occurred in 2005, and Hurricanes Gustav and Ike, which occurred in 2008. The development of the template components (i.e. beach, dune, and marsh) is discussed in the following sections.

SBEACH, a widely accepted cross-shore sediment transport model, was utilized for predicting storm-induced beach and dune erosion. The model's use is considered standard practice both in the United States and internationally as evidenced by the many documented applications in professional journals and conference proceedings. The assumptions utilized in the modeling program along with verification of use of the model are presented in Appendix L.

3.3.2.2.2 Beach and Dune Component

Based on historical natural beach and dune elevations, and SBEACH simulations that were performed on an array of various restoration plans to examine storm-induced beach and dune erosion, the following design criteria for Plan B were derived:

- Gulf-side beach width: 250 ft,
- Beach elevation: 3.8 ft NAVD 88,
- Dune width:100 ft
- Dune elevation: 6.0 ft NAVD 88, and
- Bay-side beach width: 100 ft.

Louisiana's barrier islands have poorly developed sand dunes as a result of a limited amount of aeolian transported sand and the high frequency of overwash by storms. The SBEACH dune elevations resulting from a 50-year storm simulation on a 6-ft dune (Table 2-2 in Annex L-3) fell within the range of values reported by the Louisiana Geological Survey (LGS 1989 and 1995) in Coastal Sand Dunes of Louisiana, an Inventory. LGS reported dune elevations ranging from 2 to 5 ft NGVD88 for Timbalier and East Timbalier and 0.7 to 5 ft NGVD88 for the Isles Dernieres.

3.3.2.2.3 Marsh Component

The marsh serves as a roll over platform as the islands migrate landward. Based on the post storm observations from the recent historic storms, there is ample evidence that the back barrier marsh width needs to be on the order of 1,000 ft to capture overwash sediments during episodic events; sediment that would otherwise be carried into back bay areas to form shoals or be lost into deeper waters. Cross-shore sediment transport models, e.g., SBEACH, tend to underestimate the extent of overwash. Examination of vertical aerial photographs of the Texas coast, made following Hurricane Ike, show areas of overwash extending from 800 to 1,300 ft inland (Ewing, 2009). An extensive study of overwash on the Caminada-Moreau Headland by Ritchie and Penland found that, for much of the low shoreline, overwash penetrated from 700 to more than 1,000 ft beyond the beach (Ritchie and

Penland, 1989). Examination of the aerial photographs in Williams, et al. (1992) show overwash areas extending to 1,300 ft on Timbalier Island and greater than 700 ft on East Island. Personal observations by various PDT members support planning for a minimum marsh width of 1,000 ft. Therefore, 1,000 ft was defined as the design criteria for the minimized restoration template for the marsh platform width.

Based on similar Louisiana barrier island restoration plans, the average healthy marsh elevation, defined as the target elevation for the marsh platform, is typically within +/- 0.1 ft of Mean High Water (MHW). MHW for the Study area is approximately 1.6 ft NAVD 88 and was defined as the design criteria for the minimized design plan for the marsh platform elevation. Marsh fill compaction (a combination of foundation settlement and fill consolidation) was compensated for in each island design, as described and discussed in Appendix L.

3.3.2.3 Design Plan Scalars (Plans C through E)

Plans C through E are scalars of Plan B that incorporate incremental increases in the scales of beach, dune and marsh planforms and elevations to provide plan formulators the ability to determine the optimal increment for restoration of the geomorphologic form and ecologic function of these islands. The optimal level of restoration is defined as the best balance of environmental benefits (e.g., habitat acres), constructability as constrained by available sediment volumes in identified borrow sources, and cost effectiveness. Plan C provides for the minimal geomorphologic form and ecologic function on each island along with 5 years of additional protection from background erosion/land loss (i.e. advanced fill). Plan D provides for the minimal geomorphologic form and ecologic function on each island along with 10 years of advanced fill. Plan E provides for the minimal geomorphologic form and ecologic function on each island along with 25 years of advanced fill.

The habitat acres that will be created by each plan are provided in Table 3-7. The table also identifies the borrow area that would be utilized for each plan.

Table 3-7: Summary of Created Habitat Acres

Island	Plan	Dune/ Supratidal Area at TY1 (acre)	Intertidal Habitat at TY1 (acre)	Beach/Dune Borrow Area	Marsh Borrow Area
Raccoon	Plan A	51	184	Ship Shoal	Raccoon TE-48
	Plan B	271	235	Ship Shoal	Raccoon TE-48
	Plan C	341	237	Ship Shoal	Raccoon TE-48
	Plan D	520	122	Ship Shoal	Raccoon TE-48
	Plan E	751	39	Ship Shoal	Raccoon TE-48
	Plan B w/ BW	271	237	Ship Shoal	Raccoon TE-48
	Plan C w/ BW	342	239	Ship Shoal	Raccoon TE-48
	Plan D w/ BW	521	122	Ship Shoal	Raccoon TE-48
	Plan E w/ BW	752	39	Ship Shoal	Raccoon TE-48
	Plan B w/ TG	271	237	Ship Shoal	Raccoon TE-48
	Plan C w/ TG	341	238	Ship Shoal	Raccoon TE-48
	Plan D w/ TG	520	122	Ship Shoal	Raccoon TE-48
	Plan E w/ TG	751	38	Ship Shoal	Raccoon TE-48
Whiskey	Plan A	377	443	Ship Shoal	Whiskey Area 3a
	Plan B	670	509	Ship Shoal	Whiskey Area 3a
	Plan C	895	377	Ship Shoal	Whiskey Area 3a
	Plan D	986	376	Ship Shoal	Whiskey Area 3a
	Plan E	1402	250	Ship Shoal	Whiskey Area 3a
Trinity	Plan A	238	326	South Pelto	Whiskey Area 3a
	Plan B	464	569	South Pelto	Whiskey Area 3a
	Plan C	585	564	South Pelto	Whiskey Area 3a
	Plan D	1198	72	South Pelto	Whiskey Area 3a
	Plan E	1523	67	South Pelto	Whiskey Area 3a
East	Plan A	199	59	South Pelto	Whiskey Area 3a
	Plan B	318	362	South Pelto	Whiskey Area 3a
	Plan C	385	372	South Pelto	Whiskey Area 3a
	Plan D	802	33	South Pelto	Whiskey Area 3a
	Plan E	1027	33	South Pelto	Whiskey Area 3a
Wine	Plan A	5	6	South Pelto	Whiskey Area 3a
	Plan B	109	97	South Pelto	Whiskey Area 3a
	Plan C	122	117	South Pelto	Whiskey Area 3a

Island	Plan	Dune/ Supratidal Area at TY1 (acre)	Intertidal Habitat at TY1 (acre)	Beach/Dune Borrow Area	Marsh Borrow Area
	Plan D	130	140	South Pelto	Whiskey Area 3a
	Plan E	349	17	South Pelto	Whiskey Area 3a
	Ring Only	26	3	South Pelto	NA
Timbalier	Plan A	606	374	South Pelto	Whiskey Area 3a
	Plan B	903	726	South Pelto	Whiskey Area 3a
	Plan C	1743	85	South Pelto	Whiskey Area 3a
	Plan D	1952	83	South Pelto	Whiskey Area 3a
	Plan E	2561	69	South Pelto	Whiskey Area 3a
East Timbalier	Plan A	75	133	South Pelto	Whiskey Area 3a
	Plan B	376	452	South Pelto	Whiskey Area 3a
	Plan C	1057	71	South Pelto	Whiskey Area 3a
	Plan D	1170	60	South Pelto	Whiskey Area 3a
	Plan E	1762	99	South Pelto	Whiskey Area 3a

3.3.3 Screening/Evaluation of Alternative Plans

Because of the millions of potential alternatives comprised of island measure(s) and borrow area combinations, the PDT utilized the USACE Institute for Water Resource's Planning Suite (IWR). IWR Planning Suite assists with plan formulation by combining solutions to planning problems and calculating the additive effects of each combination. It also assists with plan comparison by conducting cost effectiveness and incremental cost analyses, identifying the plans which are best financial investments – Best Buy plan alternatives, and displaying the effects of each on a range of decision variables. IWR Planning Suite 1.0.11.0 was used in IWR screening of the LCA TBBSR Study solutions.

The input variables for the IWR included habitat benefits and costs for each of the 44 island plans identified in Table 3-7. Methodologies for determining habitat benefits and costs are provided in Sections 3.3.3.1 and 3.3.3.2, respectively.

The user has the option of defining inter-variable dependencies and combinability. The "combinability" variable was defined such that none of the plans for a particular island could be paired with another plan developed for the same island. For example, Whiskey Island Plan B could not be combined with Whiskey Island Plan E. Since there were no inter-island dependencies, the "dependency" variable was not used in the IWR.

Once the costs, benefits, and combinability of each island plan were entered into the input file, the IWR was used to combine the island plans to form a series of alternatives. An alternative can be comprised of as many as seven and as few as one island plan. For alternatives with multiple island plans, the costs and benefits of each plan were summed to determine the total cost and benefit output of the alternative. The IWR also computes the cost/benefit of each alternative in order to conduct a cost-effectiveness and incremental cost analysis.

3.3.3.1 Habitat Benefits

The input parameters for the IWR screening run included habitat acres and conceptual cost estimates specific to the alternatives carried forward through the plan formulation process. Due to the large number of possible alternatives, the PDT could not feasibly conduct a Wetland Value Assessment (WVA) to determine habitat benefits (i.e. average annual habitat units [AAHUs]). Therefore, the PDT utilized average annual habitat acres (AAHAs) as a surrogate for AAHUs in this preliminary level of screening. However, the WVA is utilized in subsequent levels of screening (Section 3.5.1).

In order to calculate AAHAs, the PDT determined the number of acres of dune, supratidal, and intertidal habitat across the following target years (TY): TY0, TY1, TY5, TY10, TY20, TY30, TY40, and TY50. Habitat types were defined in accordance with the WVA:

- Dune Habitat: Habitat > 5 ft NAVD 88
- Supratidal Habitat: Habitat occurring from 2.0 ft to 4.9 ft NAVD 88
- Intertidal Habitat: Habitat occurring from 0.0 ft to 1.9 ft NAVD 88

Initial construction templates (TY1) were evolved in time to account for vertical adjustments (subsidence and sea level rise) and horizontal adjustments (background erosion and overwash). Boundaries of habitats at specific target years delineated both existing and created habitats. Template evolution and calculation of the target year acres were performed in AutoCAD.

A weighting factor of 17/14ths was then applied to the intertidal habitat acres since they provide a greater habitat benefit than the other two habitat types. The relative weight (i.e. the 17/14ths) of the intertidal habitat was reviewed by the USACE and other agency and academic experts during model development. In addition, a literature review was conducted to summarize the available scientific knowledge supporting the relative weights of the variables and their role in supporting fish and wildlife within the respective communities. The variable weights were originally developed using a sensitivity analysis in which weights were adjusted until the model behaved as expected by an interdisciplinary expert team and a consensus was reached. Unfortunately, the scientific literature to support specific numerical weightings of individual variables does not exist; however, there is general support for their relative values used in the WVA.

The dune, supratidal, and adjusted intertidal acres were summed and then averaged over the 50-yr period of analysis. This method is consistent with the WVA method for computing AAHUs except that it does not account for subtidal acreages, vegetative cover, interspersion, or the influence of structural measures. Tables 3-8 through 3-16 present the habit acres for each target year and the resulting AAHAs. A detailed description of the WVA model is provided in Section 3.5.1.

Table 3-8. Summary of Habitat Acres for Raccoon Island Restoration Plans

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	AAHA
A	Dune	0	0	0	0	0	0	0	0	92
	Supratidal	51	51	30	10	3	0	0	0	
	Intertidal	188	184	161	137	76	55	0	0	
B	Dune	0	45	33	15	1	0	0	0	393
	Supratidal	51	227	194	162	150	83	25	0	
	Intertidal	188	235	253	266	255	260	248	23	
C	Dune	0	50	38	22	8	0	0	0	489
	Supratidal	51	292	215	192	174	110	62	4	
	Intertidal	188	237	300	301	295	306	277	223	
D	Dune	0	60	45	25	14	0	0	0	554
	Supratidal	51	460	445	231	210	120	67	29	
	Intertidal	188	122	146	339	335	341	307	263	
E	Dune	0	63	50	29	20	0	0	0	692
	Supratidal	51	688	675	657	630	144	72	51	
	Intertidal	188	39	39	40	39	478	457	425	

Table 3-9. Summary of Habitat Acres for Raccoon Island Restoration Plans with Breakwaters

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	AAHA
A	Dune	0	0	0	0	0	0	0	0	92
	Supratidal	51	51	30	10	3	0	0	0	
	Intertidal	188	184	161	137	76	55	0	0	
B	Dune	0	45	33	15	6	0	0	0	418
	Supratidal	51	227	198	163	173	112	62	0	
	Intertidal	188	237	254	267	254	264	259	38	
C	Dune	0	50	38	22	8	0	0	0	520
	Supratidal	51	292	219	193	200	142	92	14	
	Intertidal	188	239	302	303	297	307	300	262	
D	Dune	0	60	45	25	14	0	0	0	587
	Supratidal	51	461	449	232	220	158	96	34	
	Intertidal	188	122	148	340	352	336	339	307	
E	Dune	0	63	50	28	20	0	0	0	727
	Supratidal	51	689	679	658	656	188	109	68	
	Intertidal	188	39	40	40	40	467	489	472	

Table 3-10. Summary of Habitat Acres for Raccoon Island Restoration Plans with Terminal Groin

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	AAHA
A	Dune	0	0	0	0	0	0	0	0	92
	Supratidal	51	51	30	10	3	0	0	0	
	Intertidal	188	184	161	137	76	55	0	0	
B	Dune	0	45	33	15	3	0	0	0	416
	Supratidal	51	227	198	165	170	107	36	0	
	Intertidal	188	237	254	267	254	264	279	34	
C	Dune	0	50	38	22	8	0	0	0	516
	Supratidal	51	292	218	194	194	137	86	12	
	Intertidal	188	238	302	302	296	307	300	258	
D	Dune	0	60	45	25	14	0	0	0	581
	Supratidal	51	460	448	232	218	156	93	34	
	Intertidal	188	122	147	341	348	332	329	303	
E	Dune	0	63	50	29	20	0	0	0	722
	Supratidal	51	688	678	659	650	182	106	66	
	Intertidal	188	38	39	40	39	466	486	468	

Table 3-11. Summary of Habitat Acres for Whiskey Island Restoration Plans

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	AAHAs
A	Dune	0	0	0	0	0	0	0	0	348
	Supratidal	377	367	40	4	0	0	0	0	
	Intertidal	443	436	692	616	468	0	0	0	
B	Dune	0	57	53	0	0	0	0	0	822
	Supratidal	377	614	220	164	0	0	0	0	
	Intertidal	443	509	830	801	786	594	410	276	
C	Dune	0	65	61	57	0	0	0	0	944
	Supratidal	377	830	328	223	84	0	0	0	
	Intertidal	443	377	808	828	847	717	472	363	
D	Dune	0	69	65	61	0	0	0	0	1015
	Supratidal	377	917	533	288	167	1	0	0	
	Intertidal	443	376	690	850	854	785	521	355	
E	Dune	0	80	76	71	0	0	0	0	1284
	Supratidal	377	1323	1127	1039	938	259	75	0	
	Intertidal	443	250	376	379	375	875	782	475	

Table 3-12. Summary of Habitat Acres for Trinity Island Restoration Plans

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	AAHAs
A	Dune	39	32	4	3	0	0	0	0	153
	Supratidal	232	206	137	52	3	1	0	0	
	Intertidal	311	326	327	245	72	19	0	0	
B	Dune	39	126	92	23	0	0	0	0	651
	Supratidal	232	338	237	208	43	0	0	0	
	Intertidal	311	569	626	629	627	460	279	33	
C	Dune	39	129	122	67	0	0	0	0	777
	Supratidal	232	456	316	270	190	4	0	0	
	Intertidal	311	564	632	635	594	561	380	199	
D	Dune	39	126	116	102	0	0	0	0	891
	Supratidal	232	1072	1004	351	324	124	0	0	
	Intertidal	311	72	73	642	578	577	501	298	
E	Dune	39	123	115	107	0	0	0	0	1187
	Supratidal	232	1399	1329	1237	1157	422	217	32	
	Intertidal	311	67	66	67	69	608	618	593	

Table 3-13. Summary of Habitat Acres for East Island Restoration Plans

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	AAHAs
A	Dune	35	23	5	4	0	0	0	0	78
	Supratidal	178	176	86	46	6	0	0	0	
	Intertidal	71	59	110	101	58	16	0	0	
B	Dune	35	88	59	18	0	0	0	0	422
	Supratidal	178	229	165	140	33	0	0	0	
	Intertidal	71	362	404	405	401	290	171	46	
C	Dune	35	89	81	50	0	0	0	0	503
	Supratidal	178	296	213	175	122	2	0	0	
	Intertidal	71	372	410	412	388	360	242	122	
D	Dune	35	84	74	67	0	0	0	0	577
	Supratidal	178	718	674	231	208	73	0	0	
	Intertidal	71	33	34	418	377	382	314	192	
E	Dune	35	77	75	69	0	0	0	0	780
	Supratidal	178	950	898	837	770	273	139	17	
	Intertidal	71	33	33	34	39	402	402	379	

Table 3-14. Summary of Habitat Acres for Wine Island Restoration Plans

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	AAHAs
A	Dune	1	0	0	0	0	0	0	0	4.8
	Supratidal	6	4	3	2	1	0	0	0	
	Intertidal	6	7	6	5	3	1	0	0	
B	Dune	1	12	11	10	0	0	0	0	151
	Supratidal	5	97	75	61	47	13	0	0	
	Intertidal	6	97	109	109	106	111	96	5	
C	Dune	1	13	12	11	0	0	0	0	185
	Supratidal	5	109	90	76	64	29	2	0	
	Intertidal	6	117	125	126	122	129	128	9	
D	Dune	1	12	11	10	9	0	0	0	217
	Supratidal	5	118	98	85	62	38	10	0	
	Intertidal	6	140	149	150	146	150	151	7	
E	Dune	1	11	10	9	8	0	0	0	323
	Supratidal	5	338	328	314	288	76	47	0	
	Intertidal	6	17	17	17	17	210	210	229	

Table 3-15. Summary of Habitat Acres for Timbalier Island Restoration Plans

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	AAHAs
A	Dune	57	53	31	8	0	0	0	0	388
	Supratidal	549	529	266	286	93	18	1	0	
	Intertidal	374	373	541	392	289	149	37	2	
B	Dune	57	155	130	13	0	0	0	0	1029
	Supratidal	549	748	566	524	236	38	1	0	
	Intertidal	374	726	811	822	829	695	450	175	
C	Dune	57	193	160	130	0	0	0	0	1254
	Supratidal	549	1550	630	496	438	134	3	0	
	Intertidal	374	85	916	933	826	833	644	373	
D	Dune	57	191	161	136	0	0	0	0	1477
	Supratidal	549	1761	1668	600	499	187	4	0	
	Intertidal	374	83	88	1041	978	994	843	571	
E	Dune	57	215	183	160	0	0	0	0	2029
	Supratidal	549	2346	2257	2130	1996	629	330	53	
	Intertidal	374	69	71	74	76	1148	1123	1088	

Table 3-16. Summary of Habitat Acres for East Timbalier Island Restoration Plans

Plan	Habitat Type	Target Year (TY)								
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	AAHAs
A	Dune	7	1	1	0	0	0	0	0	102
	Supratidal	129	74	60	46	9	2	1	0	
	Intertidal	173	133	140	111	98	49	17	4	
B	Dune	7	63	58	54	0	0	0	0	624
	Supratidal	129	314	240	199	175	70	7	0	
	Intertidal	173	452	476	474	456	459	405	7	
C	Dune	7	86	67	62	0	0	0	0	892
	Supratidal	129	972	327	238	158	52	7	0	
	Intertidal	173	71	702	714	664	587	552	496	
D	Dune	7	93	71	66	0	0	0	0	1112
	Supratidal	129	1077	1062	351	359	256	157	56	
	Intertidal	173	60	72	734	673	682	676	670	
E	Dune	7	120	83	78	0	0	0	0	1709
	Supratidal	129	1641	1617	1587	1556	444	192	244	
	Intertidal	173	99	91	86	71	1086	1227	1066	

Since the IWR requires net benefit acres for each plan, the AAHAs for the No Action plan (Plan A) were subtracted from the average annual habitat acres for each of the other plans. The resulting IWR inputs are summarized in Table 3-17.

3.3.3.2 Costs

The IWR also requires the user to input a cost for each alternative being considered. The conceptual cost estimates for each island restoration measure utilizing one or more of the sand and marsh borrow areas were determined by computing the costs based on equipment types and estimates of production rates, historical contract bids from projects of a similar nature, and professional experience. Conceptual costs were developed for individual islands in order to evaluate each measure on a level and consistent basis. Each island restoration estimate included a dredge plant for beach/dune fill and a dredge plant for marsh fill. Each dredge equipment cost estimate included pipeline, equipment mobilization/demobilization, and support plant. This method allowed for interchangeability of dredge type for beach/dune fill and marsh fill to evaluate the most efficient method of island restoration. The resulting costs that were utilized in the IWR are summarized in Table 3-17.

Table 3-17. IWR Input Parameters

Island	Description	Cost ($1000)	Acres
Raccoon	Plan A	$0	0
	Plan B	$54,400	301
	Plan C	$58,300	397
	Plan D	$64,100	462
	Plan E	$81,100	599
	Plan B with BW	$58,100	326
	Plan C with BW	$62,000	428
	Plan D with BW	$67,800	495
	Plan E with BW	$84,800	635
	Plan B with TG	$56,600	324
	Plan C with TG	$60,600	424
	Plan D with TG	$66,400	489
	Plan E with TG	$83,400	630
Whiskey	Plan A	$0	0
	Plan B	$63,500	474
	Plan C	$73,900	596
	Plan D	$84,500	667
	Plan E	$124,000	936
Trinity	Plan A	$0	0
	Plan B	$67,100	498
	Plan C	$77,600	625
	Plan D	$93,400	738
	Plan E	$136,700	1035
East	Plan A	$0	0
	Plan B	$56,400	344
	Plan C	$62,500	426
	Plan D	$72,600	500
	Plan E	$102,300	703
Wine	Plan A	$0	0
	Plan B	$42,500	147
	Plan C	$43,900	181
	Plan D	$45,800	213
	Plan E	$51,500	318

Island	Description	Cost ($1000)	Acres
	Ring[a]	$16,400	5
Timbalier	Plan A	$0	0
	Plan B	$83,400	641
	Plan C	$97,400	865
	Plan D	$113,000	1088
	Plan E	$168,000	1641
East Timbalier	Plan A	$0	0
	Plan B	$144,000	523
	Plan C	$180,000	791
	Plan D	$229,000	1011
	Plan E	$375,000	1607

BW denotes Breakwaters
TG denotes Terminal Groin
[a] This plan includes filling the existing rock ring of Wine Island

A total of 243,750 plans were generated using the IWR platform. The output included 360 cost-effective plan alternatives ranging in cost between $0 (No Action) to $1.04 billion (Raccoon with breakwaters, Whiskey, Trinity, East, Wine, Timbalier, and East Timbalier – all Plan E). Fourteen (14) of the cost effective plans were Best Buy plans. Figure 3-8 presents an IWR graph which depicts all of the plans including non cost effective, cost effective and Best Buys.

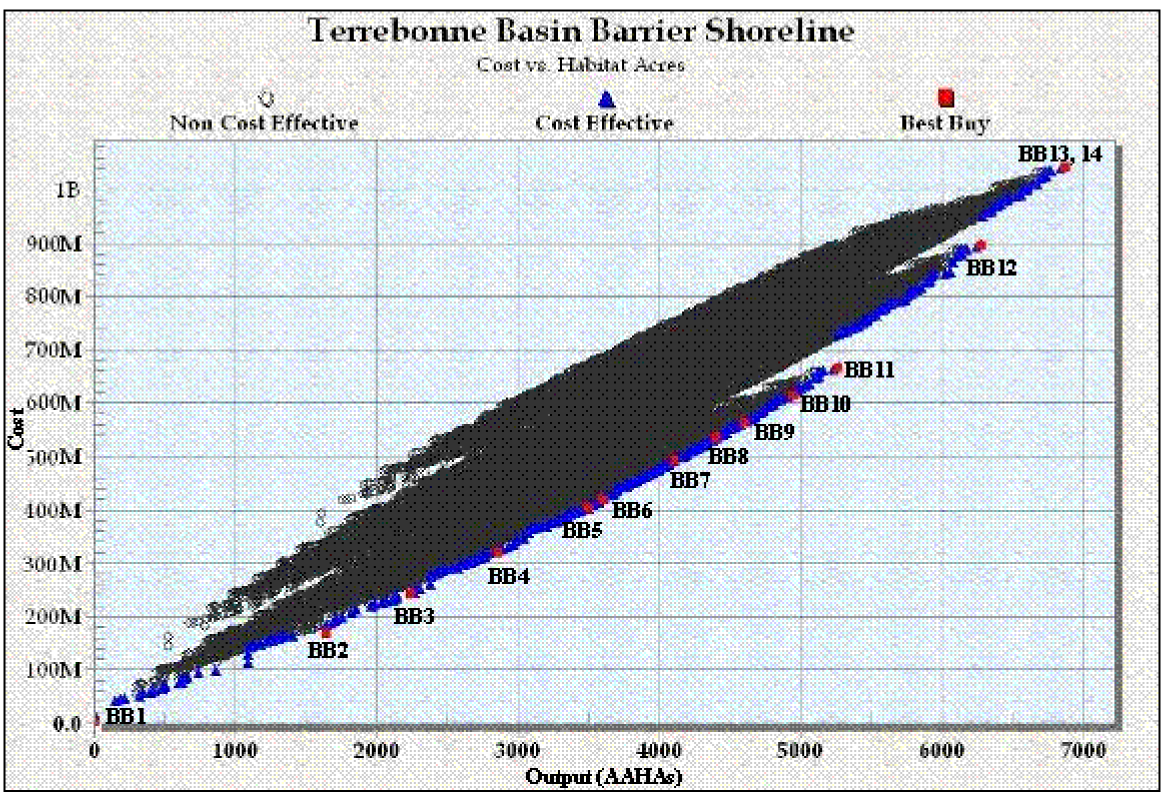

Figure 3-8. Results of Initial IWR Iteration

Of the 243,750 Generated Plans, 360 were Cost Effective (blue triangles) and 14 were Best Buys (red squares). The Best Buy plans are summarized in Table 3-18.

Table 3-18. Summary of Best Buy Plans

Best Buy Plans		AAHA	Cost ($)	Cost/AAHA
BB1	No Action	0	0	0
BB2	Timbalier (Plan E)	1,641	168,000,000	102,000
BB3	Whiskey (Plan C), Timbalier (Plane E)	2,237	242,000,000	108,000
BB4	Whiskey (Plan C), Trinity (Plan C), Timbalier (Plan E)	2,862	319,000,000	112,000
BB5	Raccoon w/TG (Plan E), Whiskey (Plan C), Trinity (Plan C), Timbalier (Plan E)	3,492	403,000,000	115,000
BB6	Raccoon w/TG (Plan E), Whiskey (Plan C), Trinity (Plan D), Timbalier (Plan E)	3,605	419,000,000	116,000
BB7	Raccoon w/TG (Plan E), Whiskey (Plan C), Trinity (Plan D), East (Plan D), Timbalier (Plan E)	4,105	491,000,000	120,000
BB8	Raccoon w/TG (Plan E), Whiskey (Plan C), Trinity (Plan E), East (Plan D), Timbalier (Plan E)	4,402	534,000,000	121,000
BB9	Raccoon w/TG (Plan E), Whiskey (Plan C), Trinity (Plan E), East (Plan E), Timbalier (Plan E)	4,605	564,000,000	122,000
BB10	Raccoon w/TG (Plan E), Whiskey (Plan E), Trinity (Plan E), East (Plan E), Timbalier (Plan E)	4,945	614,000,000	124,000
BB11	Raccoon w/TG (Plan E), Whiskey (Plan E), Trinity (Plan E), East (Plan E), Wine (Plan E), Timbalier (Plan E)	5,264	666,000,000	126,000
BB12	Raccoon w/TG (Plan E), Whiskey (Plan E), Trinity (Plan E), East (Plan E), Wine (Plan E), Timbalier (Plan E), East Timb (Plan D)	6,245	895,000,000	143,000
BB13	Raccoon w/TG (Plan E), Whiskey (Plan E), Trinity (Plan E), East (Plan E), Wine (Plan E), Timbalier (Plan E), East Timbalier (Plan E)	6,841	1,040,000,000	152,000
BB14	Raccoon w/BW (Plan E), Whiskey (Plan E), Trinity (Plan E), East (Plan E), Wine (Plan E), Timbalier (Plan E), East Timbalier (Plan E)	6,846	1,040,000,000	152,000

3.3.4 Alternative Plans not Carried Over for Further Analysis

Of the 243,750 plans that were generated by the IWR, only ten were carried forward for further analysis. Five of the plans were selected because they were the five most cost-effective Best Buy plans. Best buy plans are the most efficient plans because they provide the greatest increase in output for the least increase in costs. Best Buy Plan #5 was selected as the cutoff point because the incremental increase in output between Best Buy Plan #5 and #6 was relatively small compared to the incremental increase in cost required for the additional output (Figure 3-9). Best Buy Plan #5 also represents a multi-island option with systemic benefits although the alternative significantly exceeds the currently authorized project cost. All other Best Buy and Cost Effective Plans were eliminated.

The remaining five plans that were carried forward are unique in that they were not found to be cost-effective by the IWR. However, they provided additional benefits that were worthy of consideration and were thus carried forward for further analysis. The rationale for advancing these multi-island alternatives is based on a system wide approach of restoring as many of the islands within the Terrebonne Basin barrier system as possible. The comments received during public meetings, both project scoping and Coastal Protection and Restoration Authority stakeholder, expressed a general desire to restore all of the islands in the Terrebonne Basin. Concentrating restoration efforts on only one or two cost effective islands may well meet with public opposition. Furthermore, these alternatives may become cost-effective once AAHUs are substituted for AAHAs. These plans are discussed in more detail in Section 3.4.

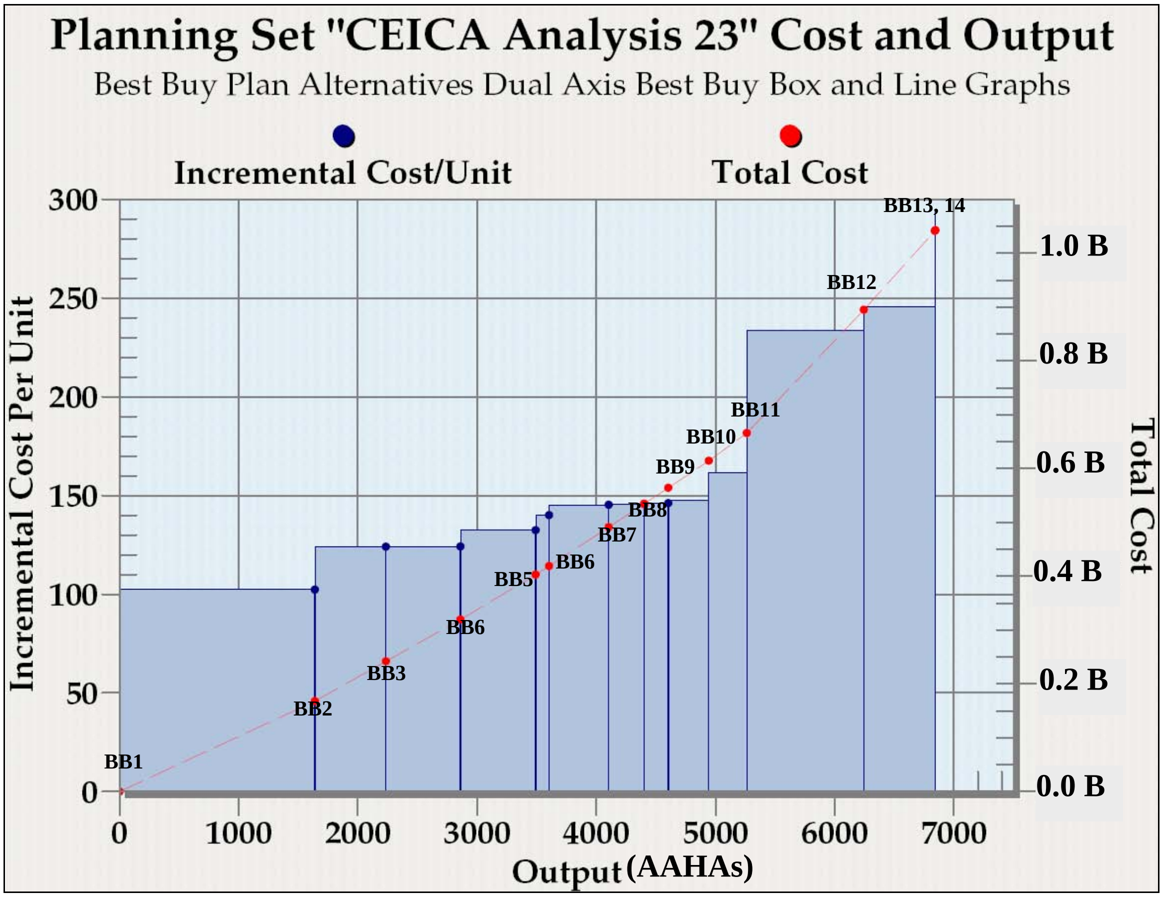

Figure 3-9. Incremental Cost and Output for the Best Buy Plans

3.4 INTERMEDIATE ARRAY OF ALTERNATIVES

Based on the results of the IWR analysis presented in Section 3.3, five Best Buy plans were recommended for inclusion in the Intermediate Array of Alternatives presented. Because the conceptual cost estimates in the IWR screening were developed separately for individual islands and dune/beach and marsh fill components, they did not account for potential reductions due to shared mobilization/demobilization as well as other fixed costs. The conceptual cost estimates were subsequently refined for analyzing and developing alternatives to carry forward into the Intermediate Array. For Best Buy plans 4 and 5, the volume of required marsh fill exceeds the volume of marsh sediments identified in the available marsh borrow areas, thus, sand borrow areas were selected to provide the additional sediment to complete the marsh fill templates. However, the sand will only be used as a base layer. An adequate layer of marsh material will be placed on the sand layer whenever it is used for marsh construction.

The WVA was applied to compute AAHUs. The Habitat Units, which represent a numerical combination of quality and quantity existing at any given point in time resulting from the Future Without and Future With scenarios, were annualized and averaged over the Study life to determine AAHUs. The difference in AAHUs between two scenarios represents the net benefits attributable to the Study in terms of habitat quality and quantity.

To apply a system-wide approach of restoring as many islands as possible within the Terrebonne Basin barrier system and to ensure that other alternatives that could provide effective solutions and are constructible with available sediment sources, additional solutions were further analyzed. All possible minimized (Plan B) three- and four-island combinations that could be constructed with available sediment sources were developed. The most cost effective combinations whose refined conceptual cost estimate did not exceed the Best Buy plans included in the Intermediate Array of Alternatives, of which there were four (4), were included in the Intermediate Array of Alternatives. Finally, a system-wide barrier island restoration measure which would restore all seven islands to their minimized design (Plan B) completed the Intermediate Array. The need to consider a system-wide approach was requested by local stakeholders through the scoping process.

In summary, the ten Intermediate Array alternatives were grouped into four (4) categories.

<u>1) No Action</u> – The No-Action Alternative assumes there would be no future barrier island restoration within the Study area. The barrier islands will continue to be subjected to the factors and processes that are contributing to the loss of the Timbalier and Isles Dernieres barrier island reaches and will result in a direct loss of the barrier islands to open water.

<u>2) "Best Buy"</u> – The best-buy alternatives are based on the IWR screening and provide the greatest increase in the value of the output variable for the least increase in the value of the cost variable. In other words, the best-buy alternative yields the maximum habitat acres at the lowest cost per unit. The "Best Buy" alternative is geared less toward the system-wide approach of restoring the entire barrier island reach and more toward restoring the island or islands that are most cost-effective.

<u>3) Maximum number of islands constructible with available sediment sources</u> - This alternative would favor those islands where the total costs are lowest, allowing for more islands to be created using available sediment sources noting they may or may not be cost effective based on the IWR screening. The rationale for advancing these alternatives is based on a system wide approach of restoring as many of the islands within the Terrebonne Basin barrier system as possible. The comments received during public meetings, both project scoping and Coastal Protection and Restoration Authority stakeholder, expressed a general desire to restore all of the islands in the Terrebonne Basin. Concentrating restoration efforts on only one or two "cost effective" islands may well meet with public opposition.

The goal of the LCA Plan is "to reverse the current trend of degradation of the coastal ecosystem. The plan maximizes the use of restoration strategies that reintroduce historic flows of river water, nutrients, and sediment to coastal wetlands, and that maintain the structural integrity of the coastal ecosystem" (LCA 2004). The Timbalier and Isles Dernieres barrier island reaches, made up of seven individual islands, define the southern extent of the Terrebonne Basin and thus provide structural integrity to all components to estuarine system further to the north. The identification of a single island solely because it is the most cost-effective alternative based on the tools and metrics prescribed for this Study discounts the benefits provided by multiple island combinations that go beyond the AAHUs. The inclusion of this category is consistent with the overall objective of the LCA Program approach and was included to provide alternatives that otherwise would have been eliminated due to the methodologies prescribed by the planning process.

<u>4) System-wide barrier island restoration</u> – This alternative would take a full system-wide approach to restoring the Terrebonne Basin barrier system. Each of the seven barrier islands would be restored to their minimal geomorphologic form and ecologic function. Similar to the alternatives that include the most islands constructible with available sediment sources, this alternative may or may not be cost effective based on the IWR screening. The rationale is the same, that being; the significant stakeholder input received during plan formulation indicates a general desire to restore all of the islands in the Terrebonne Basin. As with Category 3, the inclusion of this category is also consistent with the overall objectives of the LCA Program approach and was included to provide alternatives that otherwise would have been eliminated due to the methodologies prescribed by the planning process. It is noted that for this alternative, the volume of required marsh fill exceeds the volume of marsh sediments identified in the available marsh borrow areas, thus, sand borrow areas were selected to provide the additional sediment to complete the marsh fill templates.

Based upon the results of the plan formulation analyses and screening, ten (10) alternatives have been recommended for inclusion in the Intermediate Array of Alternatives. The alternatives consist of various combinations of islands, restoration templates (Plans B through E), and complimentary measures (terminal groins). The alternatives are discussed in the following sections and summarized in Table 3-29.

3.4.1 Alternative 1

The No-Action Alternative assumes there would be no future barrier island restoration within the Study Area. The barrier islands will continue to be subjected to the factors and processes that are contributing to the loss of the Timbalier and Isles Dernieres barrier island reaches and will result in a direct loss of the barrier islands to open water. Table 3-19 provides a summary of the habitat acres for Alternative 1 for each target year that was analyzed. The table also presents the year of disappearance for each habitat type and the AAHUs for each island.

Table 3-19. Summary of Habitat Value for Alternative 1

Island	Habitat Type	Habitat Acres								YOD[a] (TY)	AAHUs
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50		
Raccoon	Dune	0	0	0	0	0	0	0	0	NA	44
	Supratidal	51	51	30	10	3	0	0	0	TY30	
	Intertidal	188	184	161	137	76	55	0	0	TY40	
	Total	*239*	*235*	*191*	*147*	*79*	*55*	*0*	*0*	*TY40*	
Whiskey	Dune	0	0	0	0	0	0	0	0	NA	179
	Supratidal	377	367	40	4	0	0	0	0	TY17	
	Intertidal	443	436	692	616	468	375	0	0	TY31	
	Total	*820*	*803*	*732*	*620*	*468*	*375*	*0*	*0*	*TY31*	
Trinity	Dune	39	32	4	3	0	0	0	0	TY20	116
	Supratidal	232	206	137	52	3	1	0	0	TY33	
	Intertidal	311	326	327	245	72	19	0	0	TY40	
	Total	*582*	*564*	*468*	*300*	*75*	*20*	*0*	*0*	*TY40*	
East	Dune	35	23	5	4	0	0	0	0	TY20	55
	Supratidal	178	176	86	46	6	0	0	0	TY29	
	Intertidal	71	59	110	101	58	16	0	0	TY40	
	Total	*284*	*258*	*201*	*151*	*64*	*16*	*0*	*0*	*TY40*	
Wine	Dune	1	0	0	0	0	0	0	0	TY1	5
	Supratidal	6	4	3	2	1	0	0	0	TY29	
	Intertidal	6	7	6	5	3	1	0	0	TY35	
	Total	*13*	*11*	*9*	*7*	*4*	*1*	*0*	*0*	*TY35*	
Timbalier	Dune	57	53	31	8	0	0	0	0	TY20	336
	Supratidal	549	529	266	286	93	18	1	0	TY46	
	Intertidal	374	373	541	392	289	149	37	2	>TY50	
	Total	*980*	*955*	*838*	*686*	*382*	*167*	*38*	*2*	*>TY50*	
East Timbalier	Dune	7	1	1	0	0	0	0	0	TY10	66
	Supratidal	129	74	60	46	9	2	1	0	TY43	
	Intertidal	173	133	140	111	98	49	17	4	>TY50	
	Total	*309*	*208*	*201*	*157*	*107*	*51*	*18*	*4*	*>TY50*	
Total	Dune	139	109	41	15	0	0	0	0	TY20	801

Island	Habitat Type	Habitat Acres								YOD[a] (TY)	AAHUs
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50		
	Supratidal	1521	1408	621	446	114	21	2	0	TY46	
	Intertidal	1566	1517	1978	1608	1065	664	54	6	>TY50	
	Total	*3226*	*3034*	*2640*	*2069*	*1179*	*685*	*56*	*6*	*>TY50*	

[a]YOD: Year of Disappearance

Although the islands will have some habitat benefit at TY0 (i.e. 2012), they are not expected to possess adequate landmass or vegetation coverage to provide geomorphologic form or ecologic function as defined in Section 3.3.2.2.1. Furthermore, the aerial extent of the islands is expected to rapidly deplete after TY20. By TY20, the dune habitat on all seven islands is expected to disappear, followed by supratidal habitat by TY40. At TY50 (the end of our period of analysis), the only islands that are expected to have intertidal habitat are Timbalier Island (2 acres) and East Timbalier Island (4 acres). By this point, the island system will not be able to provide any considerable protection from wave action, saltwater intrusion, storm surge, or tidal currents. Additionally, the islands will no longer be able to support terrestrial or avian wildlife.

3.4.2 Alternative 2

Alternative 2 includes the restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with twenty-five years of advanced fill. Table 3-20 provides a summary of the habitat acres for Alternative 2 for each target year that was analyzed. The table also presents the year of disappearance for each habitat type and AAHUs for each island plan.

Table 3-20. Summary of Habitat Value for Alternative 2

Island	Habitat Type	Habitat Acres								YOD[a] (TY)	AAHUs
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50		
Timbalier Plan E	Dune	57	215	183	160	0	0	0	0	TY20	1207
	Supratidal	549	2346	2257	2130	1996	629	330	53	>TY50	
	Intertidal	374	69	71	74	76	1148	1123	1088	>TY50	
	Total	*980*	*2630*	*2511*	*2364*	*2072*	*1777*	*1453*	*1141*	*>TY50*	

[a] YOD: Year of Disappearance

3.4.3 Alternative 3

Alternative 3 includes the restoration of Whiskey Island to its minimal geomorphologic form and ecologic function along with five years of advanced fill combined with restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with twenty-five years of advanced fill. Table 3-21 provides a summary of the habitat acres for Alternative 3 for each target year that was analyzed. The table also presents the year of disappearance for each habitat type and AAHUs for each island plan.

Table 3-21. Summary of Habitat Value for Alternative 3

Island	Habitat Type	Habitat Acres								YOD[a] (TY)	AAHUs
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50		
Whiskey Plan C	Dune	0	65	61	57	0	0	0	0	TY20	558
	Supratidal	377	830	328	223	84	0	0	0	TY30	
	Intertidal	443	377	808	828	847	717	472	363	>TY50	
	Total	*820*	*1272*	*1197*	*1108*	*931*	*717*	*472*	*363*	*>TY50*	
Timbalier Plan E	Dune	57	215	183	160	0	0	0	0	TY20	1207
	Supratidal	549	2346	2257	2130	1996	629	330	53	>TY50	
	Intertidal	374	69	71	74	76	1148	1123	1088	>TY50	
	Total	*980*	*2630*	*2511*	*2364*	*2072*	*1777*	*1453*	*1141*	*>TY50*	
Total	Dune	57	280	244	217	0	0	0	0	TY20	1765
	Supratidal	926	3176	2585	2353	2080	629	330	53	>TY50	
	Intertidal	817	446	879	902	923	1865	1595	1451	>TY50	
	Total	*1800*	*3902*	*3708*	*3472*	*3003*	*2494*	*1925*	*1504*	*>TY50*	

[a] YOD: Year of Disappearance

3.4.4 Alternative 4

Alternative 4 includes the restoration of Whiskey and Trinity Islands to their minimal geomorphologic form and ecologic function along with five years of advanced fill combined with restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with twenty-five years of advanced fill. Table 3-22 provides a summary of the habitat acres for Alternative 4 for each target year that was analyzed. The table also presents the year of disappearance for each habitat type and AAHUs for each island plan.

Table 3-22. Summary of Habitat Value for Alternative 4

Island	Habitat Type	Habitat Acres								YOD[a] (TY)	AAHUs
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50		
Whiskey Plan C	Dune	0	65	61	57	0	0	0	0	TY20	558
	Supratidal	377	830	328	223	84	0	0	0	TY30	
	Intertidal	443	377	808	828	847	717	472	363	>TY50	
	Total	*820*	*1272*	*1197*	*1108*	*931*	*717*	*472*	*363*	*>TY50*	
Trinity	Dune	39	129	122	67	0	0	0	0	TY20	504

Island	Habitat Type	Habitat Acres								YOD[a] (TY)	AAHUs
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50		
Plan C	Supratidal	232	456	316	270	190	4	0	0	TY31	
	Intertidal	311	564	632	635	594	561	380	199	>TY50	
	Total	*582*	*1149*	*1070*	*972*	*784*	*565*	*380*	*199*	*>TY50*	
Timbalier Plan E	Dune	57	215	183	160	0	0	0	0	TY20	1207
	Supratidal	549	2346	2257	2130	1996	629	330	53	>TY50	
	Intertidal	374	69	71	74	76	1148	1123	1088	>TY50	
	Total	*980*	*2630*	*2511*	*2364*	*2072*	*1777*	*1453*	*1141*	*>TY50*	
Total	Dune	96	409	366	284	0	0	0	0	TY20	2269
	Supratidal	1158	3632	2901	2623	2270	633	330	53	>TY50	
	Intertidal	1128	1010	1511	1537	1517	2426	1975	1650	>TY50	
	Total	*2382*	*5051*	*4778*	*4444*	*3787*	*3059*	*2305*	*1703*	*>TY50*	

[a] YOD: Year of Disappearance

3.4.5 Alternative 5

Alternative 5 includes the restoration of Raccoon Island to its minimal geomorphologic form and ecologic function along with twenty-five years of advanced fill with construction of a terminal groin combined with restoration of Whiskey and Trinity Islands to their minimal geomorphologic form and ecologic function along with five years of advanced fill and restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with twenty-five years of advanced fill. Table 3-23 provides a summary of the habitat acres for Alternative 5 for each target year that was analyzed. The table also presents the year of disappearance for each habitat type and AAHUs for each island plan.

Table 3-23. Summary of Habitat Value for Alternative 5

Island	Habitat Type	Habitat Acres								YOD[a] (TY)	AAHUs
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50		
Raccoon w/TG Plan E	Dune	0	63	50	29	20	0	0	0	TY21	470
	Supratidal	51	688	678	659	650	182	106	66	>TY50	
	Intertidal	188	38	39	40	39	466	486	468	>TY50	
	Total	*239*	*789*	*767*	*728*	*709*	*648*	*592*	*534*	*>TY50*	
Whiskey Plan C	Dune	0	65	61	57	0	0	0	0	TY20	558
	Supratidal	377	830	328	223	84	0	0	0	TY30	
	Intertidal	443	377	808	828	847	717	472	363	>TY50	
	Total	*820*	*1272*	*1197*	*1108*	*931*	*717*	*472*	*363*	*>TY50*	
Trinity	Dune	39	129	122	67	0	0	0	0	TY20	504

Island	Habitat Type	Habitat Acres								YOD[a] (TY)	AAHUs
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50		
Plan C	Supratidal	232	456	316	270	190	4	0	0	TY31	
	Intertidal	311	564	632	635	594	561	380	199	>TY50	
	Total	*582*	*1149*	*1070*	*972*	*784*	*565*	*380*	*199*	*>TY50*	
Timbalier Plan E	Dune	57	215	183	160	0	0	0	0	TY20	1207
	Supratidal	549	2346	2257	2130	1996	629	330	53	>TY50	
	Intertidal	374	69	71	74	76	1148	1123	1088	>TY50	
	Total	*980*	*2630*	*2511*	*2364*	*2072*	*1777*	*1453*	*1141*	*>TY50*	
Total	Dune	96	472	416	313	20	0	0	0	TY20	2739
	Supratidal	1209	4320	3579	3282	2920	815	436	118.6	>TY50	
	Intertidal	1316	1048	1550	1577	1556	2434	2385	2078	>TY50	
	Total	*2621*	*5840*	*5545*	*5172*	*4496*	*3249*	*2820*	*2197*	*>TY50*	

[a] YOD: Year of Disappearance

3.4.6 Alternative 6

Alternative 6 includes the restoration of Raccoon, Whiskey, and Trinity Islands to their minimal geomorphologic form and ecologic function. Table 3-24 provides a summary of the habitat acres for Alternative 6 for each target year that was analyzed. The table also presents the year of disappearance for each habitat type and AAHUs for each island plan.

Table 3-24. Summary of Habitat Value for Alternative 6

Island	Habitat Type	Habitat Acres								YOD[a] (TY)	AAHUs
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50		
Raccoon Plan B	Dune	0	45	33	15	1	0	0	0	TY21	283
	Supratidal	51	227	194	162	150	83	25	0	TY48	
	Intertidal	188	235	253	266	255	260	248	23	>TY50	
	Total	*239*	*507*	*480*	*443*	*406*	*343*	*273*	*23*	*>TY50*	
Whiskey Plan B	Dune	0	57	53	0	0	0	0	0	TY10	447
	Supratidal	377	614	220	164	0	0	0	0	TY20	
	Intertidal	443	509	830	801	786	594	410	276	>TY50	
	Total	*820*	*1180*	*1103*	*965*	*786*	*594*	*410*	*276*	*>TY50*	
Trinity Plan B	Dune	39	126	92	23	0	0	0	0	TY20	394
	Supratidal	232	338	237	208	43	0	0	0	TY24	
	Intertidal	311	569	626	629	627	460	279	33	>TY50	
	Total	*582*	*1033*	*955*	*860*	*670*	*460*	*279*	*33*	*>TY50*	
Total	Dune	39	228	178	38	1	0	0	0	TY21	1125

Island	Habitat Type	Habitat Acres TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	YOD[a] (TY)	AAHUs
	Supratidal	660	1179	651	534	193	83	25	0	TY48	
	Intertidal	942	1313	1708	1696	1638	1314	937	332	>TY50	
	Total	*1641*	*2720*	*2537*	*2268*	*1832*	*1397*	*962*	*332*	*>TY50*	

[a] YOD: Year of Disappearance

3.4.7 Alternative 7

Alternative 7 includes the restoration of Raccoon, Whiskey, and Trinity Islands to their minimal geomorphologic form and ecologic function including the construction of breakwaters on Raccoon Island. Table 3-25 provides a summary of the habitat acres for Alternative 7 for each target year that was analyzed. The table also presents the year of disappearance for each habitat type and AAHUs for each island plan.

Table 3-25. Summary of Habitat Value for Alternative 7

Island	Habitat Type	Habitat Acres TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50	YOD[a] (TY)	AAHUs
Raccoon w/BW Plan B	Dune	0	45	33	15	6	0	0	0	TY21	307
	Supratidal	51	227	198	163	173	112	62	0	TY48	
	Intertidal	188	237	254	267	254	264	259	38	>TY50	
	Total	*239*	*509*	*485*	*445*	*433*	*376*	*321*	*38*	*>TY50*	
Whiskey Plan B	Dune	0	57	53	0	0	0	0	0	TY10	447
	Supratidal	377	614	220	164	0	0	0	0	TY20	
	Intertidal	443	509	830	801	786	594	410	276	>TY50	
	Total	*820*	*1180*	*1103*	*965*	*786*	*594*	*410*	*276*	*>TY50*	
Trinity Plan B	Dune	39	126	92	23	0	0	0	0	TY20	394
	Supratidal	232	338	237	208	43	0	0	0	TY24	
	Intertidal	311	569	626	629	627	460	279	33	>TY50	
	Total	*582*	*1033*	*955*	*860*	*670*	*460*	*279*	*33*	*>TY50*	
Total	Dune	39	228	178	38	6	0	0	0	TY21	1147
	Supratidal	660	1179	655	535	216	112	62	0	TY48	
	Intertidal	942	1315	1710	1697	1667	1318	948	347	>TY50	
	Total	*1641*	*2722*	*2543*	*2270*	*1889*	*1430*	*1010*	*347*	*>TY50*	

[a] YOD: Year of Disappearance

3.4.8 Alternative 8

Alternative 8 includes the restoration of Raccoon, Whiskey, and Trinity Islands to their minimal geomorphologic form and ecologic function including the construction of a terminal groin on Raccoon Island. Table 3-26 provides a summary of the habitat acres for Alternative 8 for each target year that was analyzed. The table also presents the year of disappearance for each habitat type and AAHUs for each island plan.

Table 3-26. Summary of Habitat Value for Alternative 8

Island	Habitat Type	Habitat Acres								YOD[a] (TY)	AAHUs
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50		
Raccoon w/TG Plan B	Dune	0	45	33	15	3	0	0	0	TY21	299
	Supratidal	51	227	198	165	170	107	36	0	TY48	
	Intertidal	188	237	254	267	254	264	279	34	>TY50	
	Total	*239*	*509*	*485*	*447*	*427*	*371*	*315*	*34*	*>TY50*	
Whiskey Plan B	Dune	0	57	53	0	0	0	0	0	TY10	447
	Supratidal	377	614	220	164	0	0	0	0	TY20	
	Intertidal	443	509	830	801	786	594	410	276	>TY50	
	Total	*820*	*1180*	*1103*	*965*	*786*	*594*	*410*	*276*	*>TY50*	
Trinity Plan B	Dune	39	126	92	23	0	0	0	0	TY20	394
	Supratidal	232	338	237	208	43	0	0	0	TY24	
	Intertidal	311	569	626	629	627	460	279	33	>TY50	
	Total	*582*	*1033*	*955*	*860*	*670*	*460*	*279*	*33*	*>TY50*	
Total	Dune	39	228	178	38	3	0	0	0	TY21	1140
	Supratidal	660	1179	655	537	213	107	36	0	TY48	
	Intertidal	942	1315	1710	1697	1667	1318	968	343	>TY50	
	Total	*1641*	*2722*	*2543*	*2272*	*1883*	*1425*	*1004*	*343*	*>TY50*	

[a] YOD: Year of Disappearance

3.4.9 Alternative 9

Alternative 9 includes the restoration of Raccoon, Whiskey, and Timbalier Islands to their minimal geomorphologic form and ecologic function. Table 3-27 provides a summary of the habitat acres for Alternative 9 for each target year that was analyzed. The table also presents the year of disappearance for each habitat type and AAHUs for each island plan.

Table 3-27. Summary of Habitat Value for Alternative 9

Island	Habitat Type	Habitat Acres								YOD[a] (TY)	AAHUs
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50		

Island	Habitat Type	Habitat Acres								YOD[a] (TY)	AAHUs
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50		
Raccoon Plan B	Dune	0	45	33	15	1	0	0	0	TY21	284
	Supratidal	51	227	194	162	150	83	25	0	TY48	
	Intertidal	188	235	253	266	255	260	248	23	>TY50	
	Total	*239*	*507*	*480*	*443*	*406*	*343*	*273*	*23*	*>TY50*	
Whiskey Plan B	Dune	0	57	53	0	0	0	0	0	TY10	447
	Supratidal	377	614	220	164	0	0	0	0	TY20	
	Intertidal	443	509	830	801	786	594	410	276	>TY50	
	Total	*820*	*1180*	*1103*	*965*	*786*	*594*	*410*	*276*	*>TY50*	
Timbalier Plan B	Dune	57	155	130	13	0	0	0	0	TY20	718
	Supratidal	549	748	566	524	236	38	1	0	TY41	
	Intertidal	374	726	811	822	829	695	450	175	>TY50	
	Total	*980*	*1629*	*1507*	*1359*	*1065*	*733*	*451*	*175*	*>TY50*	
Total	Dune	57	257	216	28	1	0	0	0	TY21	1448
	Supratidal	977	1589	980	850	386	121	26	0	TY48	
	Intertidal	1005	1470	1894	1889	1870	1549	1108	474	>TY50	
	Total	*2039*	*3316*	*3090*	*2767*	*2257*	*1670*	*1134*	*474*	*>TY50*	

[a] YOD: Year of Disappearance

3.4.10 Alternative 10

Alternative 10 includes the restoration of Raccoon, Whiskey, Trinity, East, Wine, Timbalier, and East Timbalier Islands, all to their minimal geomorphologic form and ecologic function. Table 3-28 provides a summary of the habitat acres for Alternative 10 for each target year that was analyzed. The table also presents the year of disappearance for each habitat type and AAHUs for each island plan.

Table 3-28. Summary of Habitat Value for Alternative 10

Island	Habitat Type	Habitat Acres								YOD[a] (TY)	AAHUs
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50		
Raccoon Plan B	Dune	0	45	33	15	1	0	0	0	TY21	284
	Supratidal	51	227	194	162	150	83	25	0	TY48	
	Intertidal	188	235	253	266	255	260	248	23	>TY50	
	Total	*239*	*507*	*480*	*443*	*406*	*343*	*273*	*23*	*>TY50*	
Whiskey Plan B	Dune	0	57	53	0	0	0	0	0	TY10	447
	Supratidal	377	614	220	164	0	0	0	0	TY20	
	Intertidal	443	509	830	801	786	594	410	276	>TY50	
	Total	*820*	*1180*	*1103*	*965*	*786*	*594*	*410*	*276*	*>TY50*	
Trinity	Dune	39	126	92	23	0	0	0	0	TY20	394

Island	Habitat Type	Habitat Acres								YOD[a] (TY)	AAHUs
		TY0	TY1	TY5	TY10	TY20	TY30	TY40	TY50		
Plan B	Supratidal	232	338	237	208	43	0	0	0	TY24	
	Intertidal	311	569	626	629	627	460	279	33	>TY50	
	Total	*582*	*1033*	*955*	*860*	*670*	*460*	*279*	*33*	*>TY50*	
East Plan B	Dune	35	88	59	18	0	0	0	0	TY20	255
	Supratidal	178	229	165	140	33	0	0	0	TY22	
	Intertidal	71	362	404	405	401	290	171	46	>TY50	
	Total	*284*	*679*	*628*	*563*	*434*	*290*	*171*	*46*	*>TY50*	
Wine Plan B	Dune	1	12	11	10	0	0	0	0	TY19	110
	Supratidal	5	97	75	61	47	13	0	0	TY31	
	Intertidal	6	97	109	109	106	111	96	5	>TY50	
	Total	*12*	*206*	*195*	*180*	*153*	*124*	*96*	*5*	*>TY50*	
Timbalier Plan B	Dune	57	155	130	13	0	0	0	0	TY20	718
	Supratidal	549	748	566	524	236	38	1	0	TY41	
	Intertidal	374	726	811	822	829	695	450	175	>TY50	
	Total	*980*	*1629*	*1507*	*1359*	*1065*	*733*	*451*	*175*	*>TY50*	
East Timbalier Plan B	Dune	7	63	58	54	0	0	0	0	TY20	435
	Supratidal	129	314	240	199	175	70	7	0	TY45	
	Intertidal	173	452	476	474	456	459	405	7	>TY50	
	Total	*309*	*829*	*774*	*727*	*631*	*529*	*412*	*7*	*>TY50*	
Total	Dune	139	546	436	133	1	0	0	0	TY21	2643
	Supratidal	1521	2567	1697	1458	684	204	33	0	TY48	
	Intertidal	1566	2950	3509	3506	3460	2869	2059	565	>TY50	
	Total	*3226*	*6063*	*5642*	*5097*	*4145*	*3073*	*2092*	*565*	*>TY50*	

[a] YOD: Year of Disappearance

Table 3-29. Summary of Intermediate Array of Alternatives

Alternative		Category	Net AAHUs[a]	Preliminary Costs[b] ($)	Annualized Costs[c] ($)	Annualized Cost/AAHU	Description
1	No Action (Plan A)	Best Buy	0[d]	0	-	-	This alternative does not include any restoration.
2	Timbalier (Plan E)	Best Buy	871	170,000,000	8,710,000	10,000	Restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with twenty-five years of advanced fill.
3	Whiskey (Plan C) / Timbalier (Plan E)	Best Buy	1250	247,000,000	12,640,000	10,120	Restoration of Whiskey Island to its minimal geomorphologic form and ecologic function along with five years of advanced fill combined with restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with twenty-five years of advanced fill.
4	Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)	Best Buy	1637	329,000,000	16,820,000	10,280	Restoration of Whiskey and Trinity Islands to their minimal geomorphologic form and ecologic function along with five years of advanced fill combined with restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with twenty-five years of advanced fill.
5	Raccoon with TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)	Best Buy	2063	408,000,000	20,830,000	10,100	Restoration of Whiskey and Trinity Islands to their minimal geomorphologic form and ecologic function along with five years of advanced fill combined with restoration of Raccoon and Timbalier Islands to their minimal geomorphologic form and ecologic function along with twenty-five years of advanced fill and construction of a terminal groin on the western end of Raccoon Island.
6	Raccoon (Plan B) / Whiskey (Plan B) / Trinity (Plan B)	Max # of Islands Constructible with Available Sediment Sources	785	177,000,000	9,040,000	11,510	Restoration of Raccoon, Whiskey, and Trinity Islands, all to their minimal geomorphologic form and ecologic function.
7	Raccoon with BW (Plan B) / Whiskey (Plan B) / Trinity (Plan B)	Max # of Islands Constructible with Available Sediment Sources	808	182,000,000	9,280,000	11,490	Restoration of Raccoon, Whiskey, and Trinity Islands, all to their minimal geomorphologic form and ecologic function, along with construction of eight additional breakwaters on the western end of Raccoon Island.

Alternative		Category	Net AAHUs[a]	Preliminary Costs[b] ($)	Annualized Costs[c] ($)	Annualized Cost/AAHU	Description
8	Raccoon with TG (Plan B) / Whiskey (Plan B) / Trinity (Plan B)	Max # of Islands Constructible with Available Sediment Sources	801	180,000,000	9,190,000	11,470	Restoration of Raccoon, Whiskey, and Trinity Islands, all to their minimal geomorphologic form and ecologic function, along with construction of a terminal groin on the western end of Raccoon Island.
9	Raccoon (Plan B) / Whiskey (Plan B) / Timbalier (Plan B)	Max # of Islands Constructible with Available Sediment Sources	890	199,000,000	10,160,000	11,420	Restoration of Raccoon, Whiskey, and Timbalier Islands, all to their minimal geomorphologic form and ecologic function.
10	Raccoon (Plan B) / Trinity (Plan B) / East (Plan B) / Whisky (Plan B) / Timbalier (Plan B) / East Timbalier (Plan B) / Wine (Plan B)	System-wide Barrier Island Restoration	1842	439,000,000	22,420,000	12,170	Restoration of Raccoon, Whiskey, Trinity, East, Wine, Timbalier, and East Timbalier Islands, all to their minimal geomorphologic form and ecologic function.

BW: Breakwaters
TG: Terminal Groin
[a] Net AAHUs are calculated by subtracting the FWOP from the FWP conditions for each of the alternatives
[b] Refined cost represent the total project costs. The costs account for potential reductions due to shared mobilization/demobilization as well as other fixed costs as described in Appendix L
[c] Preliminary Costs were annualized at a discount rate of 4.375%, with a base year of 2012. The price level is 2009
[d] Net AAHUs for Alternative 1 (No Action Plan) are zero because there is no project in place to provide additional benefits.

3.5 Comparison of Alternative Plans

Study alternatives have been evaluated to determine the relative ecosystem benefits projected for each restoration approach. A cost-effectiveness analysis and incremental cost analysis were performed by comparing the expected benefits of various island strategies over a series of target years during the period of analysis. Benefits for ecosystem function have been determined for the alternatives using the WVA methodology, described below.

3.5.1 Benefit Analysis

The WVA was chosen as the most appropriate ecological model to assess ecosystem restoration benefits for the Study based on a number of factors. It is a quantitative, habitat-based assessment methodology developed to prioritize Louisiana coastal restoration projects submitted for funding under Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA). The WVA quantifies changes in fish and wildlife habitat quality and quantity that are expected to result from a proposed project. The results of the WVA, measured in Average Annual Habitat Units (AAHUs), can be combined with cost data to provide a measure of effectiveness of a proposed project in term of annualized cost per AAHU gain. Habitat Units (HU) represent a numerical combination of quality and quantity existing at any given point in time. The HUs resulting from the Future Without and Future With project scenarios are annualized (averaged over the project life) to determine AAHUs. The difference in AAHUs between the two scenarios represents the net benefits attributable to the Study in terms of habitat quality and quantity. The WVA methodology provides an estimate of the number of acres benefited or enhanced by the Study and the net acres of habitat protected or restored. WVA was developed specifically to apply to habitat types present along the Louisiana coast. The types of variables measured by the WVA community models are sensitive to the types of changes that are intended outcomes for barrier shoreline and marsh restoration. The variables measured by WVA are also recognized scientifically and technically as important in characterizing overall habitat quality. Variables utilized in the WVA were selected from existing, widely accepted Habitat Evaluation Procedures (HEP) models. The variables were constituted such that data were easily estimated or collected from existing data sources.

The specific community model used to evaluate the ecosystem benefits of the Study alternatives was the Barrier Island Community Model. The model was developed with detailed consideration of peer reviewed scientific literature, existing data bases, as well as professional experiences. In addition, unpublished ecological studies and data sets, as well as professional judgments from many different Federal and State agency personnel and academics were considered in developing and supporting the assumptions, variables, and other model components. WVA models employ a community approach which assumes that optimal conditions for all fish and wildlife within a specific type of coastal wetland habitat can be characterized by a group of significant variables, and that existing or future conditions can be compared to that optimum, providing an index of habitat quality similar to those developed under HEP.

HEP is widely used by the US Fish and Wildlife Service and other Federal and State agencies in evaluating the impacts of development projects on fish and wildlife resources. However, the HEP generally uses a species-oriented approach, whereas the WVA utilizes a community approach. The WVA models have been developed for determining the suitability of coastal wetlands in providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species.

The WVA model is presently undergoing model certification in accordance with USACE EC 1105-2-407, May 2005 Planning Models Improvement Program: Model Certification. The WVA model has undergone external review which is documented in the July 8, 2009, Draft Model Certification Review Report for the Wetland Value Assessment Models prepared by the Battelle Memorial Institute for the US Army Corps of Engineers, Ecosystem Planning Center of Expertise. The WVA revision documentation and spreadsheets have been submitted to the Ecosystem Center of Expertise (ECO-PCX). The ECO-PCX has reviewed the revisions and will forward a recommendation to certify the model for use in the LCA projects.

Since the WVA was still in the process of being certified by the ECO-PCX, the projects using the WVA model were required to respond to specific comments related to the ongoing certification process and the use of WVA on the specific project. The specific comments and responses for the WVA as it relates to the LCA TBBSR Study can be found in Appendix K. Based on satisfactory responses to these comments Planning Center of Expertise for Ecosystem Restoration has cleared the WVA model for use in evaluating the alternatives considered in this report.

The WVA Barrier Island Community Model utilizes seven variables to quantify habitat value. Information on the evolution and justification of these variables can be found in the guidance document for the model (CWPPRA, 2002). The variables are discussed in the following sections:

<u>Variable V1: Dune Habitat</u> - Dune habitat is defined as subaerial habitat $\geq$ 5 ft NAVD 88 and encompasses foredune, dune, and reardune. Although dune habitat occurs at elevations below 5ft NAVD 88, lower-elevation dunes are more ephemeral and more frequently overwashed, which reduces their habitat value. The variable is calculated as the percent of the total subaerial area that is classified as dune habitat.

<u>Variable V2: Supratidal Habitat</u> – Supratidal habitat occurs from 2.0 ft NAVD 88 to 4.9 ft NAVD 88. This habitat type primarily encompasses swale and may include low-elevation dune and beach habitat. The variable is calculated as the percent of the total subaerial area that is classified as supratidal habitat.

<u>Variable V3: Intertidal Habitat</u> – Intertidal habitat occurs from 0.0 ft NAVD 88 to 1.9 ft NAVD 88. This habitat type encompasses intertidal marsh, mudflats, beach, and any other habitat within that elevation range on the gulfside and bayside of the barrier island. The variable is calculated as the percent of the total subaerial area that is classified as supratidal habitat.

<u>Variable V4: Vegetative Cover</u> – The variable is calculated as the percent of vegetative cover of the dune, supratidal, and intertidal habitats. Dune species commonly include beach tea, bitter panicum, morning glory, and marshhay cordgrass. Common supratidal species include goldenrod, marshhay cordgrass, saltgrass, saltwort, seashore paspalum, and smooth cordgrass. Intertidal species typically include smooth cordgrass, and black mangroves.

<u>Variable V5: Woody Species</u> – This variable is intended to capture the habitat value of areas vegetated by woody species. Common woody species include black mangrove, eastern baccharis, wax myrtle, and marshelder. The variable is calculated as the percent of the subaerial vegetated area consisting of at least two woody species.

<u>Variable V6: Edge and Interspersion</u> – This variable is intended to capture the relative juxtaposition of intertidal, subaerial habitat (vegetated and unvegetated) and intra-island aquatic habitats such as ponds, lagoons, and tidal creeks associated with barrier islands. The variable is made up of five classes:

- *Class 1 (V6 = 1.0): Represents unvegetated flats and healthy back-barrier marsh with a high degree of tidal creeks, tidal channels, ponds, and/or lagoons.*
- *Class 2 (V6 = 0.8): Represents a high degree of interspersion, but usually indicates the beginning of marsh breakup and degradation.*
- *Class 3 (V6 = 0.6): Represents the development of larger open water areas due to overwash and subsidence. Class 3 is also applied to projects designed to create intertidal marsh because they lack functionally distinct interspersion and provide basically one intertidal habitat type.*
- *Class 4 (V6 = 0.4): Represents extreme stages of subsidence of the dominance of breaching with unstable overwash flats.*
- *Class 5 (V6 = 0.1): Consists of no emergent, intertidal land.*

A high degree of dispersion is considered to be optimal (V6 = 1.0) and the lowest expression of interspersion (open water) is assumed to be less desirable in terms of community-based function quality (V5 = 0.1).

<u>Variable V7: Beach Zone Habitat</u> – This variable is intended to capture the habitat value of the beach/surf zone. The variable is made up of five classes:

- *Class 1 (V7 = 1.0): Natural beach / unconfined disposal*
- *Class 2 (V7 = 0.8): Confined disposal*
- *Class 3 (V7 = 0.9): Breakwaters*
- *Class 4 (V7 = 0.2): Rock on beach*
- *Class 5 (V7 = 0.1): Seawall / no emergent habitat*

A Project Information Sheet (PIS) was developed by the USFWS to document the rationale used to quantify the variables and associated suitability indices for each alternative in the Intermediate Array. The PIS is provided Appendix B.

Table 3-30 presents a summary of the variables calculated for Raccoon Island Plan B. As seen in this example, percentages of dune and supratidal habitat are highest at TY1 (i.e. immediately after construction) and are eventually converted to intertidal habitat through overwash and subsidence.

Variable 4 indicates that vegetative covering is lowest at TY1 since the vegetation is not planted until TY2 or TY3. By TY5, vegetation has been planted and is established. However, vegetative coverage decreases after TY5 as the vegetated dune disappears. At TY1, the percentage of vegetation that is woody species (V5) is relatively high because of the existing mangrove flats that were avoided during construction. This percentage drastically decreases by TY5. Although the mangrove flats are still present, they represent a much smaller percentage of the total vegetated area once the dunes and marshes are planted with grasses.

Interspersion (V6) is relatively low at TY0, but only slightly increases after construction. This is because newly constructed marsh is categorized as a Class 3 since it does not have any tidal inlets or canals. However, by TY5, intertidal inlets have begun to form, thus creating a more optimal interspersion condition. After TY5, subsidence and overwash continuously increase interspersion to sub-par levels.

Variable 7 quantifies the effects of hard structures on the surf zone habitat. In this particular example, a hard structure has not been proposed for Plan B. However, there are two existing breakwater fields that impact approximately 55% of the beach. Therefore, 55% of the island was categorized as Class 3 (breakwaters) and the remaining 45% was categorized as Class 1 (natural beach). It was assumed that the breakwaters would no longer be effective at TY30 and that the entire island would be categorized as Class 1.

Table 3-30. WVA Variables for Raccoon Island Plan B

Target Year	V1	V2	V3	V4	V5	V6	V7
TY0	0%	21%	79%	17%	43%	0.64	0.95
TY1	9%	45%	46%	16%	43%	0.70	0.95
TY5	7%	40%	53%	64%	12%	0.98	0.95
TY10	3%	37%	60%	60%	15%	0.95	0.95
TY20	0%	37%	63%	52%	22%	0.78	0.95
TY30	0%	24%	76%	37%	23%	0.70	1.00
TY40	0%	9%	91%	22%	23%	0.68	1.00
TY50	0%	0%	100%	14%	20%	0.40	1.00

The variables are combined in the following equation to yield a Habitat Suitability Index (HSI):

$$HSI = 0.14(V1) + 0.14(V2) + 0.17(V3) + 0.20(V4) + 0.10(V5) + 0.15(V6) + 0.10(V7)$$

The HSI is then multiplied by the total Study area to determine HUs. Habitat Units represent a numerical combination of quality (HIS) and quantity (acres) existing at any given point in time. The HUs resulting from the Future Without and Future With Project scenarios are annualized (averaged over the project life) to determine AAHUs. The "benefit" of a project can be quantified by comparing AAHUs between the Future Without and Future With Project scenarios. The difference in AAHUs between the two scenarios represents the net benefit attributable to the Study in terms of habitat quantity and quality.

The variable weights used to calculate the HIS were originally developed using a sensitivity analysis in which weights were adjusted until the model behaved as expected by an interdisciplinary expert team and a consensus was reached. Since their original development, the model has been revised as issues have arisen during its application. These changes have often modified the procedures used or the guidance for valuing specific variables. Prior to its use model behavior has been assed via various means of internal testing using test data sets and variable sensitivity tests using the full range of variable values.

3.5.2 Cost Effectiveness and Incremental Cost Analyses

For environmental planning, where traditional benefit-cost analysis is not possible because costs and benefits are expressed in different units, two analytical methods are used to assist in the decision process. First, cost effectiveness analysis is conducted to ensure that the least cost solution is identified for each possible level of environmental output. Subsequent incremental cost analysis of the cost effective solutions is conducted to reveal changes in costs for increasing levels of environmental outputs producing "Best Buy" plans which are simply those plans that provide increases in output at the lowest average cost. In the absence of a common measurement unit for comparing the non-monetary benefits with the monetary costs of environmental plans, cost effectiveness and incremental cost analysis are valuable tools to assist in decision making. It is important to keep in mind that the most useful information developed by these two methods is what it tells decision makers about the relative relationships among solutions - that one will likely produce greater output than another, or one is likely to be more costly than another - rather than the specific numbers that are calculated. Furthermore, these analyses will usually not lead, and are not intended to lead, to a single best solution (as in economic cost-benefit analysis); however, they will improve the quality of decision making by ensuring that a rational, supportable approach is used in considering and selecting alternative methods to produce environmental outputs.

Cost Effectiveness and Incremental Cost Analyses (CE/ICA) are applied to evaluate alternative plans and identify a NER Plan. The process ensures the NER Plan meets the planning objectives and constraints and reasonably maximizes environmental benefits while meeting tests of completeness, acceptability, efficiency, and effectiveness. The NER Plan is usually based on the array of Best Buy plans identified during the cost effectiveness and incremental cost analysis.

The CE/ICA analysis follows guidance from the USACE Institute for Water Resources publication, Evaluation of Environmental Investment Procedures Manual, Interim: Cost Effectiveness and Incremental Analyses, May 1995, IWR Report #95-R-1. The costs are converted to average annual costs and include PED and construction costs, interest during construction, as well as operations and maintenance costs after construction. The benefits were derived from the WVA and are also in the form of average annual outputs.

3.5.2.1 Cost Effectiveness

Table 3-31 displays the six cost-effective plans in the Intermediate Array. The cost effective plans are the alternatives that produce the most benefits for the same or less cost. A description of the cost effectiveness analysis is included in the Incremental Costs Analysis Appendix (Appendix K).

Table 3-31. Cost Effective Alternatives

Code	Description	Outputs (AAHU)	Annualized Cost ($)	Annualized Cost/ AAHU
Alt 1	No Action (Plan A)	0	0	0
Alt 2	Timbalier (Plan E)	871	8,710,000	10,000
Alt 9	Raccoon (Plan B) / Whiskey (Plan B) / Timbalier (Plan B)	890	10,160,000	11,420
Alt 3	Whiskey (Plan C) / Timbalier (Plan E)	1250	12,640,000	10,120
Alt 4	Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)	1637	16,820,000	10,280
Alt 5	Raccoon with TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)	2063	20,830,000	10,100

Figure 3-10 graphically presents the ten alternatives in the Intermediate Array. Note that the cost-effective and Best Buy alternatives fall along the efficient frontier.

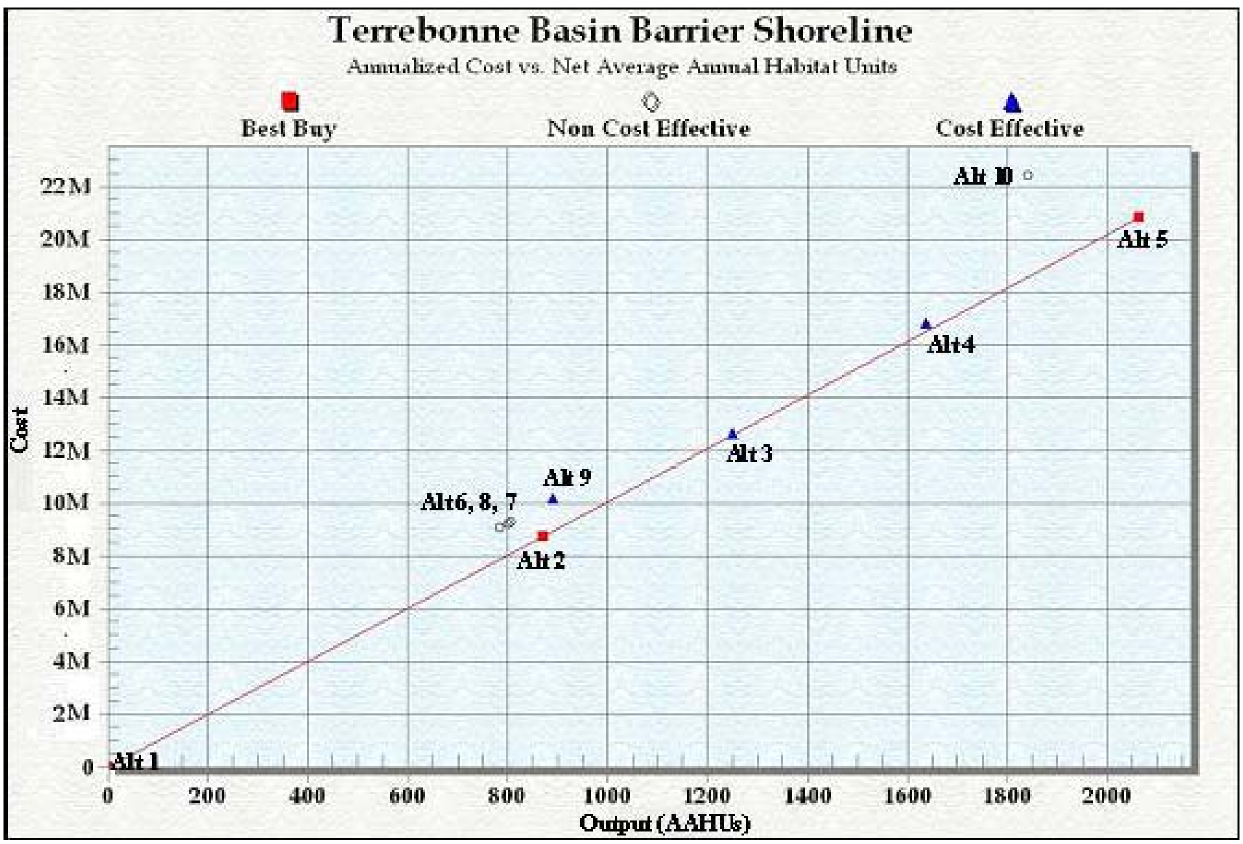

Figure 3-10. Results of Final IWR Iteration

As seen in Figure 3-10, the CE/ICA analysis revealed that Alternatives 6, 7, 8, and 10 were not cost-effective when compared to the other alternatives in the

Intermediate Array. Alternatives 6, 7, and 8 provide 785, 808, and 801 Net AAHUs at a cost of $177,000,000, $182,000,000, and $180,000,000, respectively. However, Alternative 2 provides more benefits (871 AAHUs) for less cost ($170,000,000). Therefore, Alternatives 6, 7, and 8 are not cost-effective when compared to Alternative 2. Similarly, Alternative 10 provides fewer benefits (1842 AAHUs) than Alternative 5 (2063 AAHUs) at a greater cost and was therefore not cost-effective.

Although there is a general positive sloping trend between costs and outputs (i.e. benefits), the trend is not completely linear. A combination of factors contribute to this non-linearity including number of islands in the alternative, characteristics of the existing island footprints, and the extent to which the islands are being restored. For example, Alternative 2 consists of restoring Timbalier Island (the largest island in the system) using the largest island plan (Plan E). Alternatives 6, 7, and 8 will restore three smaller islands (Raccoon, Whiskey, and Trinity) using smaller island plans (Plan B). These alternatives will require three separate mobilization/demobilization events (compared to just one for Alternative 2), considerably increasing the costs per benefit. Furthermore, Timbalier currently has a considerable amount of subaerial habitat and a shallow sloping subtidal region behind the island. Therefore, the restoration plan will require relatively less material to increase its habitat value when compared to Alternatives 6, 7, and 8 which will require fill placement in deeper water.

This phenomenon can also be seen when comparing Alternative 5 to Alternative 10. Although Alternative 5 is only restoring four islands (compared to seven islands in Alternate 10), it will produce a larger amount of AAHUs. This is because the islands in Alternative 5 are being restored using larger plans (Plan E for Raccoon and Timbalier and Plan C for Whiskey and Trinity) than Alternative 10, which restores the islands to the minimum plan (Plan B). Furthermore, the additional mobilization/ demobilization costs associated with a seven-island plan also increase the cost per benefit.

3.5.2.2 Incremental Cost Analysis

The cost effectiveness and incremental cost analyses process is an iterative process. For the incremental cost analysis, the cost effective alternative plans were sorted in order of increasing output (Table 3-32). Next, the plan with the lowest average annual cost per AAHU beyond the "No-Action" plan was identified and selected as the first "Best Buy" plan. The process continues, searching for the greatest increases in output for the least increases in cost. The alternatives were analyzed in all possible combinations. A description of the incremental cost analysis is located in the Benefit/Cost – Incremental Analysis Appendix (Appendix K).

Table 3-32. Incremental Cost Analysis

Code	Outputs	Total	Additional	Additional	Incremental	Category

	(AAHU)	Cost ($)	Output (AAHU)	Costs ($)	Costs ($/AAHU)	
Alt 1	0	0	-	-	0	Best Buy
Alt 2	871	170,000,000	871	170,000,000	195,000	Best Buy
Alt 9	890	199,000,000	19	29,000,000	1,530,000	Cost Effective
Alt 3	1,250	247,000,000	360	48,000,000	133,000	Cost Effective
Alt 4	1,637	329,000,000	387	82,000,000	212,000	Cost Effective
Alt 5	2,063	408,000,000	426	79,000,000	185,000	Best Buy

A graphical representation of the incremental analysis for the "Best Buy" plans (excluding the No Action Plan) is provided in Figure 3-11. As seen in the figure, Alternative 5 provides considerably more output for a slight increase in incremental cost.

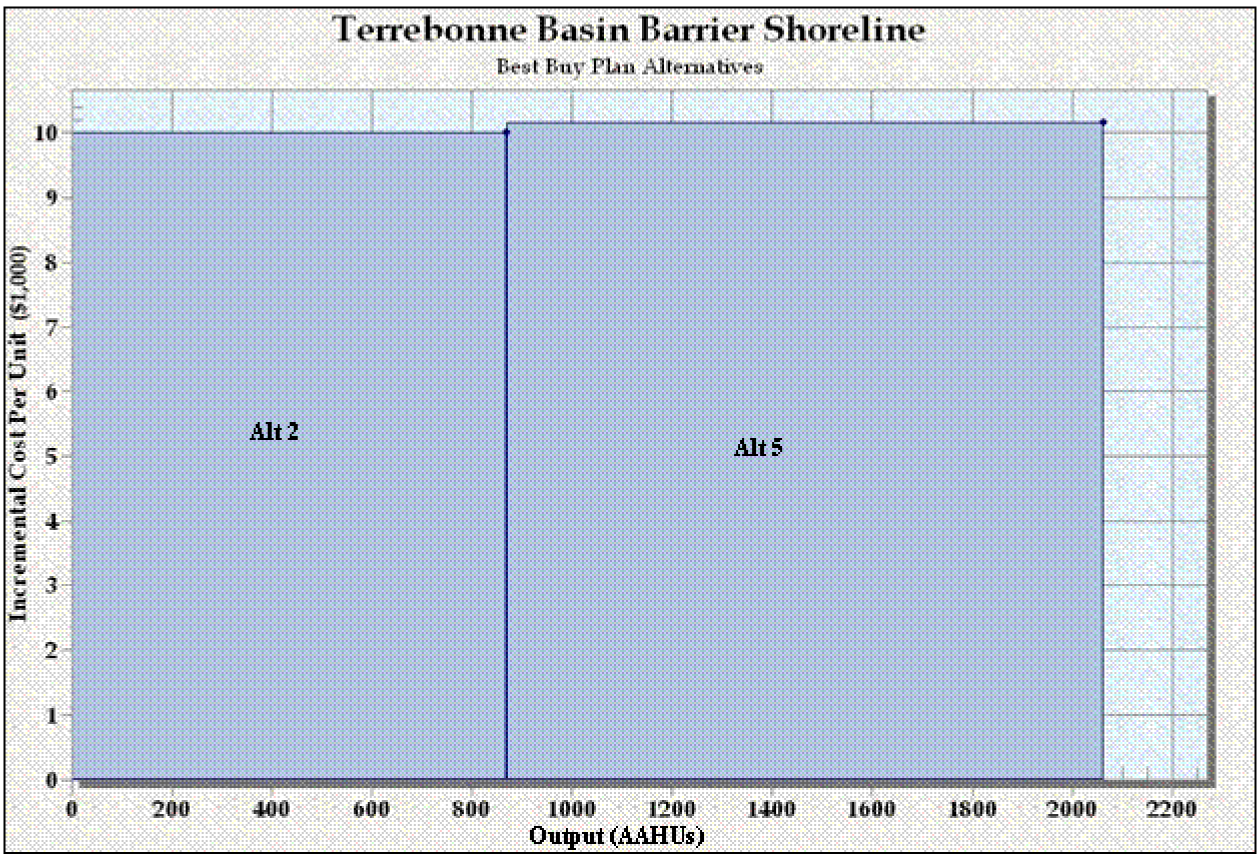

Figure 3-11. Incremental cost and output for the Best Buy plans

3.5.2.3 Final Array of Alternatives

The ten alternatives that were selected for the Intermediate Array were further analyzed and screened to narrow the alternative selection to a final array of five alternatives and the no action plan. The resulting Final Array consists of the following alternatives:

- Alternative 2: Timbalier (Plan E)
- Alternative 3: Whiskey (Plan C)/Timbalier (Plan E)
- Alternative 4: Whiskey (Plan C)/Trinity (Plan C)/Timbalier (Plan E)
- Alternative 5: Raccoon with TG (Plan E)/Whiskey (Plan C)/Trinity (Plan C)/Timbalier (Plan E)
- Alternative 11: Whiskey (Plan C)

These alternatives were carried forward for detailed analysis because they were all cost effective and fell along the efficient frontier curve. Alternatives 6, 7, 8, 9, and 10 were not cost effective and therefore, not carried forward for further analysis. Alternative 9 was also removed from further analysis because the cost per AAHU was significantly (14%) higher than Alternative 2 and it fell above the efficient frontier curve. Alternative 11 was added to the final array because none of the alternatives in the intermediate array were within WRDA 2007 authorization. Discussion of the development and selection of Alternative 11 is included in Section 3.7.

3.6 NER PLAN

The USACE objective in ecosystem restoration planning is to contribute to the NER Plan. Contributions to national ecosystem restoration (NER outputs) are increases in the net quantity and/or quality of desired ecosystem resources. Measurement of NER is based on changes in ecological resource quality as a function of improvement of habitat quality and/or quantity and expressed quantitatively in physical units or indexes (ER 1105-2-100).

As identified through three levels of screening, the measures carried forward into the alternatives development stage included, at a minimum, a beach, dune, and marsh component. During the plan formulation PDT meetings, the NER Plan was defined as the most cost effective plan that yielded the optimal habitat benefits from restoring the geomorphologic form and ecologic function of the beach, dune and marsh components on one or more of the islands.

Alternative 5 (Raccoon with Terminal Groin (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / and Timbalier (Plan E)) was selected as the NER Plan because it is a Best Buy plan that fulfills the planning objectives in Section 2.3 of this report. The NER Plan would restore the geomorphologic form and ecologic function of the four islands in the Terrebonne Basin barrier system. Immediately after construction (TY1), the NER Plan would add 3,283 acres of habitat (dune, intertidal, and supratidal) to the existing island footprints of Raccoon, Whiskey, Trinity, and Timbalier Islands, increasing the total size of the islands to 5,840 acres. This would result in the restoration and creation of approximately 472 acres of dune, 4,320 acres of supratidal habitat, and 1,048 acres of intertidal habitat.

The creation of dune, supratidal, and intertidal habitats would provide essential habitats for fish, migratory birds, and other terrestrial and aquatic species. Furthermore, by using the proposed borrow areas, the Study would increase sediment input to supplement longshore sediment transport processes along the gulf shoreline by mechanically introducing compatible sediment, and increasing the ability of the restored area to continue to function and provide habitat with minimum continuing intervention. Sediment placed on Trinity Island would eventually be transported to Whiskey Island and Raccoon Island as the sediment moves westward through the system. Raccoon Island would also receive sediment directly from Whiskey.

The NER Plan was also selected because it would protect existing critical habitat on Raccoon and Whiskey Islands. Raccoon Plan E and Whiskey Plan C were designed to avoid approximately 58 and 286 acres of existing mangroves on the islands, respectively, thereby minimizing potential adverse ecologic impacts during construction. Since these two islands are considered to be valuable wildlife habitats

(Isles Dernieres Barrier Islands Wildlife Refuge) and the LDWF is reestablishing a pelican rookery on Whiskey Island, maintaining adequate areas of healthy beach, dune, and marsh is particularly important. Raccoon, Whiskey, Trinity, and Timbalier are also a critical habitat for endangered species including the piping plover and are a valuable stopover habitat for migratory birds.

In addition to protecting and maintaining ecological benefits, the NER Plan would protect existing State investments on the island. For example, Whiskey Plan C was designed to complement TE-50, which is an existing CWPPRA project that was constructed in 2009. TE-50 created approximately 316 acres of intertidal back-barrier marsh between the two existing mangrove stands. Restoration of the beach and dune gulfward of TE-50 will supplement the existing CWPPRA investment.

Raccoon Plan E was designed to complement two separate CWPPRA projects, TE-29 and TE-48. The TE-29 project, which was completed in July 1997, included the construction of eight segmented breakwaters along the eastern end of the island. The TE-48 project consists of two phases. Phase A, which included the construction of eight additional segmented breakwaters and a terminal groin, was completed in September of 2005. The terminal groin, which was constructed on the eastern end of the island, was intended to prevent longshore currents from scouring accumulated sediment behind the breakwater field. Phase B, which is currently in the pre-construction phase, will include the construction of a 53-acre marsh along the backside of the island. The resilience of Raccoon Island Plan E is partially due to the existing breakwaters from both CWPPRA projects. The plan would help protected the marsh that will be constructed as part of TE-48.

The existing mangrove stands and CWPPRA projects on Raccoon and Whiskey Island can be avoided without undermining the proposed action because they are the only areas of sufficient elevation to complement the design template and to contribute to the geomorphologic form and ecologic function of the islands. Avoidance of other pockets of existing habitat could potentially undermine the project by providing "weak spots" in the template. These areas could be more susceptible to breaching and could accelerate erosion. Therefore, the remaining 124 acres of habitat on Raccoon Island and 201 acres on Whiskey Island would be covered with fill material during construction of the template (i.e. at TY1). Existing habitat on Trinity and Timbalier Islands can not be avoided without jeopardizing the proposed action. Although the entire footprints of both islands (564 acres on Trinity and 955 acres on Timbalier) would be covered with fill material, these areas would be restored through the vegetative planting efforts immediately following construction. The habitat composition of the islands immediately preceding construction (i.e. TY1) is provided in Table 3-19.

The non-Federal sponsor fully supports Alternative 5 as the NER Plan under the current authorization.

3.6.1 Renourishment

The initial plan formulation process focused on the identification of the alternative which provided the best performance in the absence of future enhancements. Based on initial construction costs and benefits, Alternative 5 was determined to be a Best Buy and was identified as the NER Plan. However, none of the alternatives considered met the evaluation criteria of acceptability per ER 1105-2-100. More specifically, none of the alternatives were found to provide a sustainable environment and subsequently would not be capable of maintaining the Study objectives. Consequently, O&M in the form of renourishment was added to each of the islands found in the Intermediate Array.

The PDT optimized the renourishment quantity and sequencing by determining the minimum amount needed to maintain the geomorphic form and ecologic function of the islands throughout the 50-year period of analysis. The first step in this process involved determining the minimum width of the supratidal beach that would not breach during each of the three design storms (i.e. the Katrina/Rita event, the Gustav/Ike event, and the 50-yr design storm). Comparisons of the SBEACH modeling results revealed that the Katrina/Rita event resulted in the largest amount of shoreline erosion at 104 ft. Therefore, the supratidal beach must be at least 104 ft wide in order to prevent breaching and thus maintain the geomorphologic form and ecologic function.

With the minimum supratidal beach dimensions set at 104 ft, the PDT utilized an iterative process to determine the most appropriate target years for renourishment. This was accomplished by restoring the dune and supratidal portions of various islands plans (i.e. Plan B, Plan C, Plan D, and Plan E) at various target years. The minimum island plan and maximum renourishment interval that maintained the geomorphologic form and ecologic function throughout the period of analysis was selected as the renourishment configuration. This approach minimized the amount of sediment needed for renourishment, thus reducing costs. The resulting configurations are provided in Table 3-33. Marsh renourishment was not included since the initial restoration plan provides for significant intertidal habitat throughout the 50 year period of analysis.

Table 3-33. Renourishment sequencing and quantities

Island Plan	Renourishment Year	Renourishment Plan
Raccoon Plan E w/ TG	TY30	Restore Plan B
Whiskey Plan C[a]	TY20	Add Plan C
	TY40	Add Plan B
Trinity Plan C	TY25	Add Plan C
Timbalier Plan E	TY30	Restore Plan B

[a] Whiskey would require two renourishments, one at TY20 and one at TY40

An additional incremental analysis was conducted on each of the 10 alternatives in the Intermediate Array. The analyses utilized an extrapolation of preliminary cost and benefit data (i.e. AAHUs) for each alternative to predict the cost-effectiveness of renourishment. When compared to all other alternatives with renourishment, Alternative 5 with renourishment is still a Best Buy per the CE/ICA analysis (Figure 3-12).

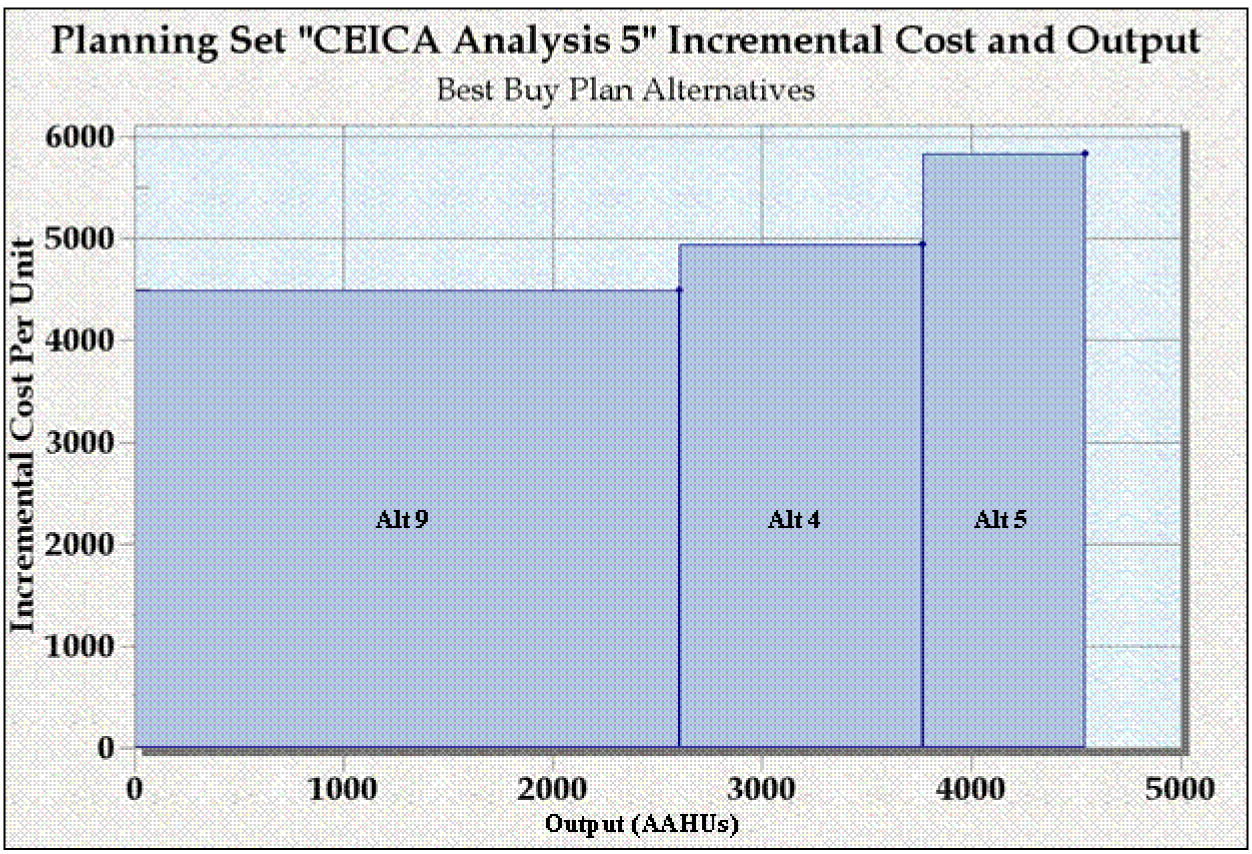

Figure 3-12. Incremental cost and output for the Best Buy plans with Renourishment

When each island with renourishment is incrementally analyzed individually and in all possible combinations, other alternative combinations not previously identified in the Intermediate Array provided cost effective solutions. The identified NER Plan falls within the uncertainty band of cost-effective plans, but not on the cost effective frontier. The major difference between the results of the analysis of the initial ten alternatives versus the analysis of the individual combination of islands is the effect of discounting the future costs of the renourishment cycles resulting in alternatives with costs in the outlying years appearing to be more cost effective than those alternatives with greater initial construction costs. The analysis of all possible combinations determined that the alternative that is the same as the previously determined NER Plan with the exception of the inclusion of Timbalier Plan B instead of Timbalier Plan E is more cost effective. While the benefits created by both plans are similar, the alternative with Plan B appears to be more cost effective because its costs are further in the future, while the Plan E is more costly during the initial construction. However, greater potential for, and certainty of benefits is attained in the initial construction. As a result, the previously identified four-island plan remains the NER Plan.

Raccoon Plan E would be renourished at TY30 by adding adequate sediment such that the dune and supratidal beach acres would be equivalent to that of a newly constructed Plan B template (i.e. restore a Plan B at TY30). No additional marsh material would be added. The resulting habitat acres, including renourishment, are provided in Table 3-34.

Whiskey Plan C would require two renourishment intervals. The first would occur at TY20 and would include the addition of the same amount of dune and supratidal beach habitat that was originally created in TY1 (i.e. add a Plan C to the template at TY20). The second renourishment interval would occur at TY40 and would include the addition of the same amount of dune and supratidal beach habitat needed to construct a Plan B template. No additional marsh material would be added. The resulting habitat acres, including renourishment, are provided in Table 3-34.

Trinity Plan C would be renourished at TY25 by adding the same amount of dune and supratidal beach habitat that was originally added in TY1 (i.e. add a Plan C to the template at TY20). No additional marsh material would be added. The resulting habitat acres, including renourishment, are provided in Table 3-34.

Timbalier Plan E would be renourished at TY30 by adding adequate sediment such that the dune and supratidal beach habitat acres would be equivalent to the acres of a newly constructed Plan B template (i.e. restore a Plan B at TY30). No additional marsh material would be added. The resulting habitat acres, including renourishment, are provided in Table 3-34.

Table 3-34. Habitat Acres for Alternative 5 (NER PLAN) – Future With Project (FWP) Conditions

Island	Habitat Type	Habitat Acres – FWP												
		TY0	TY1	TY5	TY10	TY20	TY21	TY25	TY26	TY30	TY31	TY40	TY41	TY50
Raccoon w/TG Plan E	Dune	0	63	50	29	20	18	10	8	0	45	15	14	3
	Supratidal	51	688	678	659	650	603	416	369	182	204	165	166	170
	Intertidal	188	38	39	40	39	82	253	295	466	468	486	484	468
	Total	*239*	*789*	*767*	*728*	*709*	*703*	*679*	*672*	*648*	*717*	*666*	*664*	*641*
Whiskey Plan C	Dune	0	65	61	57	0	65	61	61	57	51	0	57	0
	Supratidal	377	830	328	223	84	496	375	344	223	209	84	387	164
	Intertidal	443	377	808	828	847	834	782	769	717	693	472	461	363
	Total	*820*	*1272*	*1197*	*1108*	*931*	*1395*	*1218*	*1174*	*997*	*953*	*556*	*905*	*527*
Trinity Plan C	Dune	39	129	122	67	0	0	0	129	122	113	34	30	0
	Supratidal	232	456	316	270	190	170	90	496	320	311	230	216	90
	Intertidal	311	564	632	635	594	595	597	590	561	543	380	362	199
	Total	*582*	*1149*	*1070*	*972*	*784*	*765*	*687*	*1215*	*1003*	*967*	*644*	*608*	*289*
Timbalier Plan E	Dune	57	215	183	160	0	0	0	0	0	155	13	12	0
	Supratidal	549	2346	2257	2130	1996	1859	1313	1176	629	667	524	495	236
	Intertidal	374	69	71	74	76	183	612	719	1148	1146	1123	1120	1088
	Total	*979*	*2630*	*2511*	*2364*	*2072*	*2043*	*1925*	*1895*	*1777*	*1968*	*1660*	*1626*	*1324*
Total	Dune	95	472	416	313	20	83	71	198	179	364	62	113	3
	Supratidal	1209	4320	3579	3282	2920	3129	2193	2385	1354	1391	1003	1264	660
	Intertidal	1315	1048	1550	1577	1556	1694	2244	2373	2892	2849	2461	2427	2118
	Total	*2619*	*5840*	*5545*	*5172*	*4496*	*4905*	*4508*	*4956*	*4425*	*4604*	*3526*	*3803*	*2781*

The modeling analysis of Whiskey Island (Table 3-3) showed that the additional benefits provided by the breakwaters could not be justified by the additional costs associated with their construction. Consequently, they were eliminated in accordance with the "efficiency" criteria stipulated by ER1105-2-100 (USACE, 2000). The PDT revisited this analysis to confirm that the incorporation of renourishment would not impact the cost effectiveness of the breakwaters.

The breakwaters were designed to reduce longshore erosion rates for a period of 20 years. During the 20-year period, the structures would be maintained and repaired, if necessary. After 20 years, the effectiveness of the structural measures is projected to substantially diminish because of the sea-level change, subsidence, and barrier island landward migration. Maintenance of the structures to the original design after 20 years will no longer result in the same level of function and benefits as the original structures once provided. For example, as the islands continue to migrate further landward, they would become spatially disconnected from the breakwaters. Even if the breakwaters were completely rebuilt to their original design at TY20, they would be too far from the island to be effective.

After 20 years, the longshore erosion rates are expected to return to pre-construction conditions. Consequently, the islands are expected to lose their geomorphic form and ecologic function prior to TY50 and will be susceptible to breaching. Therefore, a renourishment event will be required to sustain the islands for the entire 50-year period of analysis.

Although the addition of breakwaters will delay the renourishment event to a later target year, they cannot be used in lieu of renourishment. That is, the alternative for Whiskey Island with breakwaters will still require renourishment to sustain the island's geomorphic form and ecologic function for the entire 50-year period of analysis. Therefore, the additional construction and O&M costs associated with the breakwaters still can not be justified by the additional benefits they provide. This also applies to additional breakwaters on Raccoon Island as well as breakwaters on Trinity and Timbalier Island.

3.6.2 Costs

The preliminary cost estimates that were used when evaluating the Intermediate Array were refined for the NER Plan using the Micro-Computer Aided Cost Estimating System (MCACES), Second Generation (MII) to develop a baseline project cost for initial restoration (Appendix L). The refinements included a more detailed assessment of costs associated with mobilization/demobilization, refined dredge-to-fill ratios, beach/dune fill placement, marsh fill placement, containment dikes, access channel, sand fencing, vegetative plantings, surveying, PED, construction management, adaptive management, and post-construction monitoring. Details of these refinements can be found in Appendix L. A formal risk analysis was also performed using Crystal Ball software to refine the preliminary cost contingency for the initial restoration efforts (Appendix L). The baseline project costs were then escalated to the mid-point of design, construction, and monitoring to account for predicted expenditure timeframes (Appendix L). Based on these refinements, the resulting fully funded cost of the NER Plan was determined to be $689,000,000 without renourishment. A breakdown of the fully funded cost is provided in Table 3-35.

Table 3-35 Fully Funded Cost Summary for NER Plan Initial Restoration

Project Element	Fully Funded Total[a]
Lands & Damages	$715,000
Fish & Wildlife (Adaptive Management Plan)	$5,820,000
Breakwaters & Seawalls	$2,494,000
Beach Replenishment	$619,000,000
PED	$30,000,000
Construction Management	$31,000,000
NER Initial Restoration Fully Funded Costs	$689,000,000

[a] Includes contingency; Does not include renourishment

Renourishment costs, including the mobilization/demobilization events and the cost of dredging the sediment, were later added to the MCACES to determine the ultimate cost of the NER Plan. Based on a total renourishment cost of approximately $557,000,000, the fully funded cost for the NER Plan with renourishments is approximately $1,246,000,000.

3.6.3 Significance of Ecosystem Outputs

Chapter 2 of ER 1105-2-100 requires plan formulators to consider significant resources and significant effects when comparing and selecting alternatives. Significance of resources and effects are derived from institutional, public, and technical recognition. Resource significance is expanded in Section 4.2.

3.6.3.1 Institutional Significance

Significance based on institutional recognition means that the importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups. The following sections discuss the specific plans, policies, and acts that support the construction of the NER Plan (with renourishment).

Master Plan

Louisiana's Comprehensive Master Plan for a Sustainable Coast (Master Plan) identifies barrier shoreline restoration of Terrebonne Basin as a specific element of the plan (Plan No. 3a-14). This element proposes the use of sediment dredged from offshore sources to reestablish sustainable barrier islands and barrier headlands. The barrier shoreline extends from Bayou Lafourche west to Raccoon Island, and includes the Caminada Headland west of Belle Pass (CPRA, 2007). The construction of restoration plans for Raccoon, Whiskey, Trinity, and Timbalier Islands will directly contribute to the achievement of the State's goal of restoring the Terrebonne Basin barrier shoreline.

CWPPRA

While the Federal government has been concerned with and involved in Louisiana's coastal land loss problem for decades, enactment of CWPPRA in 1990 marked the first Federal statutory mandate for restoration of Louisiana's coastal wetlands. The CWPPRA mandates preparation of an annual Priority Projects List (PPL). These lists consist of projects that address gulf and inland shoreline protection, sediment and freshwater diversions, terracing, vegetative plantings, marsh creation, hydrologic restoration, marsh management, and barrier island restoration.

There have been two separate CWPPRA projects proposed for Raccoon Island, TE-29 and TE-48. As previously stated, the TE-29 project, which was completed in July 1997, included the construction of eight segmented breakwaters along the eastern end of the island. Phase A of TE-48, which included the construction of eight additional segmented breakwaters and a terminal groin, was completed in September of 2005. The terminal groin, which was constructed on the eastern end of the island, was intended to prevent longshore currents from scouring accumulated sediment behind the breakwater field. Phase B, which is currently in the pre-construction phase, will include the construction of a 53-acre marsh along the backside of the island. The resilience of Raccoon Island Plan E is partially due to the existing breakwaters from both CWPPRA projects.

Two CWPPRA projects have been authorized and constructed on Whiskey Island since 2000: TE-27 and TE-50. The objective of the TE-27 was to close the breach at Coupe Nouvelle and thereby fortify the Gulf shoreline from Coupe Nouvelle to the eastern end of the island. TE-50 was recently constructed to increase the longevity of the previous TE-27 restoration effort by increasing the island's width, providing sand fencing, and stabilizing the restoration efforts with vegetation (LDNR, 2009).

The objective of CWPPRA project TE-24 was to close the existing breaches on Trinity Island. The project also aimed to increase the elevation and width of the island, and to restore the back barrier marshes. TE-24 was successfully completed in June of 1999.

Timbalier Island was the focus of two CWPPRA projects; TE-18 and TE-40. TE-18 was a planting demonstration project that included the installation of sand fencing along 7,400 ft of shoreline on the island. The goal of the project was to increase the elevation of the island and the associated vegetative covering. The project was completed in July of 1996. The second CWPPRA project, TE-40, was completed in December of 2004. The project restored approximately 2.2 miles of beach and dune and created a marsh platform. Approximately 11,500 ft of sand fencing were later added to the Study area.

The authorization of the seven CWPPRA projects on Raccoon, Whiskey, Trinity, and Timbalier Island proves that there is a need and a desire to restore and maintain the islands on both a State and Federal level. Although the NER Plan is not a CWPPRA project, it directly contributes to achieving the goals and objectives of CWPPRA by restoring four critical barrier islands in the Isle Dernieres and Timbalier Reaches.

Endangered Species Act of 1973
The Endangered Species Act of 1973, as amended, requires the designation of critical habitat for all threatened and endangered species. Critical habitat is habitat essential for the conservation or recovery of an endangered or threatened species. In the July, 2001 Final Rule (Federal Register, Vol. 66, No. 132), the USFWS designated Raccoon, Whiskey, Trinity, East, and Timbalier Islands as critical habitat for wintering populations of the endangered piping plover. The construction of the NER Plan, which will restore four of the five islands mentioned above, will create additional habitat for the piping plover and will sustain this habitat beyond the year of disappearance predicted for the FWOP conditions.

Terrebonne Parish Coastal Zone Management Program
One of the specific goals outlined by the Terrebonne Parish Coastal Zone Management (TPCZM) Program is to maintain the integrity of the Isles Dernieres for the protection of interior marshes, local infrastructure, and coastal communities. In order to meet this goal, the CZM developed three policies, one of which is to encourage the use of barrier island restoration practices to maintain or increase island elevation, preventing washover during storms and further deterioration of the islands (TPLCPAC, 2000). The construction Raccoon Plan E, Whiskey Plan C, Trinity Plan C, and Timbalier Plan E will increase the width and elevations of the existing islands through the restoration and creation of the beach and dune components. The plans also include the construction of back-barrier marshes to catch washover sediment during storm events.

Relationship to USACE Campaign Plan

As previously stated, the second goal of the USACE Campaign Plan is to deliver enduring and essential water resource solutions through collaboration with partners and stakeholders. Construction of the NER Plan will achieve this goal because it prolongs the life and restores the habitat value of four critical islands (Raccoon, Whiskey, Trinity, and Timbalier Island) in the barrier island system. Restoration of the islands is expected to increase storm surge and wave height mitigation, which will assist in Gulf Coast recovery. The NER Plan was also designed to endure a Katrina/Rita event, an Ike/Gustav event, and a 50-year design storm plus an additional five years of background erosion and subsidence. Furthermore, this project is a collaborative effort between CPRA, USFWS, NOAA, USACE, and public stakeholders.

3.6.3.2 Public Significance

Public recognition indicates that a certain segment of the general public considers the resource significant. The following sections discuss public input in support of the NER Plan (with renourishment).

NEPA Public Scoping Meeting
The USACE published a scoping meeting announcement to request comments regarding the scope of the Terrebonne Basin Barrier Shoreline Restoration Study. The meeting was held on Tuesday, February 10, 2009, in Houma, Louisiana. A total of 74 specific comments were expressed. The comments were categorized according to their applicability to the SEIS. SEIS categories include purpose and need, alternatives, affected environment, environmental consequences and consultation, coordination, and compliance with regulations.

There were a considerable number of comments that stressed the need to protect the barrier islands in the area: "Our barrier islands are our first line of defense both for storm surge protection and protection of the estuaries. This is the first study that focuses strictly on our barrier island chain from Belle Pass westward over for the Terrebonne and Lafourche or Lafourche Basin barrier island chain and everybody wants this project" (USACE, 2009). Several respondents stressed the urgency of project implementation. The NEPA Scoping Meeting is discussed in greater detail in Section 6.0.

National Audubon Society
The National Audubon Society has designated the Isles Dernieres and Timbalier Islands as Important Bird Areas (IBA). The remote nature of these islands makes them extremely valuable to nesting, wintering, and migrant birds since they are rarely disturbed by anthropogenic activities or large populations of mammalian predators. The National Audubon Society identified coastal erosion and sea level rise as the primary threats to the IBA (National Audubon Society, 2010). The construction of the restoration plans for Raccoon, Whiskey, Trinity, and Timbalier Islands will help to sustain bird populations in the IBA by creating additional

habitat acres for bird populations and by preserving the 344 acres of existing mangrove stands on Raccoon and Whiskey Island.

3.6.3.3 Technical Significance

Technical recognition of a resource is based on technical criteria. The following sections discuss the technical significance of the NER Plan (with renourishment).

Status and Trends

There is currently no dune habitat on Raccoon or Whiskey Islands. Simulated erosion of the islands for FWOP conditions reveals that the supratidal and intertidal habitat for Raccoon Island is expected to disappear by TY30 and TY40, respectively. For Whiskey, supratidal and intertidal habitat is expected to disappear by TY17 and TY31, respectively. The dune, supratidal, and intertidal habitats on Trinity are expected to disappear by TY20, TY33, and TY40, respectively. Although Timbalier is expected to retain some intertidal habitat after TY50, the dune and supratidal habitat are expected to disappear by TY20 and TY46, respectively.

The NER Plan (with renourishment) will create and sustain dune habitat until at least TY41 for each island and supratidal and intertidal habitat beyond the 50-year period of analysis. By extending the life of each habitat type on the island, the NER Plan is technically significant.

Limiting Habitat

The USFWS designated Whiskey Island as critical habitat for wintering populations of the endangered piping plover. The island also hosts healthy populations of brown pelicans, which were recently removed from the Threatened and Endangered Species List. The construction of Whiskey Island Plan C will create additional habit for the piping plover and brown pelicans and will sustain this habitat beyond the year of disappearance predicted for the FWOP conditions.

Wave Height and Storm Surge Mitigation

In 2003, Stone et al. conducted a pilot study to evaluate the impacts of barrier islands and wetlands deterioration on storm surge and wave energy along the Isles Dernieres and Timbalier Islands. The study compared storm surge elevations and significant wave heights for historic conditions (1950), recent conditions (the 1990s), and anticipated future conditions (2020). When comparing 1950 to 1990, the modeling outputs revealed that the marsh shoreline directly behind the islands experienced a 10-ft increase while the remaining portion of the Study Area experienced a 6-ft increase in storm surge. The model also revealed a 4 to 5-ft increase in significant wave height along the marsh shoreline. This considerable increase in storm surge and wave height was directly attributed to the 24% loss of barrier island and marsh landmass that occurred during the period of analysis (1950-1990). The cumulative effects of the increased wave height and storm surge resulted in the inundation of an additional 80,000 acres of landmass within the Study Area (Stone et al 2003).

Between 1990 and 2020, the model also predicted considerable increases in storm surge elevations and significant wave heights. Storm surge increases of 10 ft to 12 ft (and greater) were found along the bay fringing the marsh north of the Isles Dernieres. The marshes flanking Terrebonne Bay experienced surge increases of 1 to 6 ft. Significant wave height increased by up to 5 ft along the Isles Dernieres and the marsh shoreline behind the islands while increases along Timbalier island ranged from 6 to 8 ft. Due to the collective effects of increased wave height and storm surge elevation, it was predicted that a Class 3 hurricane would inundate an additional 35,000 acres of landmass in 2020 when compared to the 1990s (Stone et al 2003).

The authors of the study concluded that the physical loss of the Isles Dernieres and Terrebonne Islands and associated marshes has resulted and will continue to result in increased storm surge elevations and significant wave heights (Stone et al 2003). Although the authors of the study did not examine the incremental impacts of individual islands on wave height and storm surge mitigation, it can reasonably be inferred that the NER Plan will reduce weather-induced erosion on the marshes north of Raccoon, Whiskey, and Trinity Islands.

3.6.4 Acceptability, Completeness, Effectiveness, and Efficiency

Acceptability
The NER Plan is implementable from a technical, environmental, economic, financial, political, legal, institutional, and social perspective. Furthermore, the USACE and CPRA find the plan satisfactory. Therefore, the NER Plan (with renourishment) is acceptable to the Federal sponsor as well as the non-Federal sponsor. The NER Plan was selected by an interagency and interdisciplinary team. The Terrebonne Parish CZM also finds the four-island NER Plan acceptable.

Completeness
When selecting the NER Plan, the PDT considered a number of factors beyond its control including real estate, operation and maintenance, monitoring, and sponsorship factors. These factors were considered because of their potential impacts on the realization of the NER Plan.

In order to define property ownership, required estates, and potential relocations, a Real Estate Plan (REP) was developed specifically for the NER Plan (Appendix J). An Adaptive Management Plan was developed to describe the post-construction monitoring activities proposed for the NER Plan, including costs and duration of the activities (Appendix I). Operation and Maintenance of the alternatives was considered during plan formulation, particularly for the proposed hard structures (see Section 3.6.9) and renourishment (see Section 3.6.1). Sponsorship factors, particularly related to the non-Federal sponsor, were considered in the analysis (Appendix L). The cost risk analysis also quantifies external risks associated with fuel prices, severe weather downtime, pipeline length, bidder's risk, steel prices, and hurricane demobilizations. Risks and Uncertainties associated with numerical models and relative sea-level rise are discussed in Section 3.8.

Since the above-mentioned external factors and risks were considered during the selection of the NER Plan, the Federal and non-Federal sponsors agree that the plan is complete.

Effectiveness
Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities. The problems that were identified for the Terrebonne Basin Barrier Shoreline include the following:

1. Land loss due to erosion threatens the geomorphic and hydrologic barrier systems
2. Loss of barrier island/headland ecosystem habitat
3. Freshwater wetlands are impacted by increased salinity
4. Longshore sediments are significantly reduced, limiting the ecosystem's ability to be self-sustaining

Problem #1: Land loss would be reversed on Raccoon, Whiskey, Trinity, and Timbalier Islands with the construction of the NER Plan. Immediately after construction (TY1), the NER Plan will add 3,283 acres of habitat (dune, intertidal, and supratidal) to the existing island footprints of Raccoon, Whiskey, Trinity, and Timbalier Islands, increasing the total size of the islands to 5,840 acres. This includes approximately 472 acres of dune, 4,320 acres of supratidal habitat, and 1,048 acres of intertidal habitat. The dimensions of the island template for Raccoon Plan E, Whiskey Plan C, Trinity Plan C, and Timbalier Plan E will provide geomorphologic form and ecologic function (as defined in Section 3.3.2.2.1) plus an additional 25, 5, 5, and 25 years of advanced fill, respectively. The island templates are expected to provide incidental wave dampening effects and storm surge mitigation landward of the island. The remaining islands in the Isles Dernieres and Timbalier Island Reaches will continue to erode at their current rate and will provide diminishing protection from waves and storm surge. However, Whiskey Island will benefit from additional sediment placed on Trinity Island due to longshore drift. Similarly, Raccoon Island (the western-most island in the NER Plan) will benefit from sediment placed on Whiskey Island. Sediment from Timbalier Island is lost in Cat Island Pass and thus does not contribute to the islands in the Isles Dernieres.

Problem #2: Construction of the NER Plan (with renourishment) will create an additional 2883 AAHUs on the existing island footprints, increasing the total ecosystem habitat benefits of Raccoon, Whiskey, Trinity, and Timbalier Islands to 3558 AAHUs. For the FWOP conditions on Raccoon Island, supratidal and intertidal habitat is expected to disappear by TY30 and TY40, respectively. Supratidal and intertidal habitat on Whiskey Island is expected to disappear by TY17 and TY31, respectively. There is currently no dune habitat on either island. If no action is taken, the dune, supratidal, and intertidal habitat on Trinity Island will disappear by TY20, TY33, and TY40, respectively. Timbalier Island will retain only 2 acres of intertidal habitat at TY50 and will loose all dune and supratidal habitat by TY20 and TY46, respectively. The NER Plan (with renourishment) will create and sustain dune habitat for each island beyond TY40 and supratidal and intertidal habitat beyond the 50-year period of analysis. Furthermore, the NER Plan is expected to mitigate habitat loss of the mainland directly bay-ward of the islands. Habitat loss of the remaining islands in the Isles Dernieres and Timbalier Island Reaches will continue at its current rate (see Table 3-19).

Problem #3: While the NER Plan is expected to create some localized reductions of saltwater intrusion into the freshwater marshes north of Isle Dernieres and Timbalier Island reaches, the impacts are expected to be minimal. Furthermore, the extent of these benefits is extremely difficult to quantify. To evaluate the role of the islands and their intervening passes in open water circulation and turbulent mixing will require installation of long-term monitoring instruments.

Problem #4: Sediment transport along the Isles Dernieres is complex given its fragmented nature (Georgiou et al., 2005). Overall, sediment moves in a westerly direction along the Isles Dernieres island reach, although local bidirectional transport occurs on Trinity and Whiskey Islands. Sediment movement around Whiskey Pass is largely nonexistent. Within Whiskey Island, longshore sediment transport is bi-directional. Along the east flank of the island net transport is approximately 5,000 cy per year and directed east toward Whiskey Pass. However, net transport along the center of the island is westward toward Caillou Bay and Raccoon Island and increases to approximately 80,000 cy per year (Stone and Zhang, 2001). Toward the west end of Whiskey Island the westerly net transport decreases to approximately 50,000 cy per year. This amount of sediment enters Caillou Bay. Longshore sediment transport on the east end of Raccoon Island is approximately 10,000 cy per year and directed west. Depths within Caillou Bay between Raccoon Island and Whiskey Island range from 4 ft NAVD 88 to 7 ft NAVD 88 and are less than the depth of closure of 10.5 ft NAVD 88. This indicates that this area is within the zone of active sediment transport and up to 10,000 cy per year may be bypassed from Whiskey Island across Caillou Bay to Raccoon Island.

Based on this analysis of existing sediment transport data, it is concluded that after beach fill is placed on Whiskey Island during construction of the NER Plan, some of the losses associated with profile equilibration and background erosion along Whiskey Island will be bypassed across Caillou Bay to feed Raccoon Island. Since Raccoon Island is considered a valuable wildlife habitat along with Whiskey Island

(Isles Dernieres Barrier Islands Wildlife Refuge), maintaining adequate areas of healthy beach, dune, and marsh is particularly important. Restoration of Whiskey Island and subsequent longshore transport and bypass to the west will complement the TE-29 and TE-48 projects on Raccoon Island (NRCS, 2007), and will supplement the existing CWPPRA investments.

According to Georgiou et al. (2005), net sediment movement along the Timbalier Islands is to the west, and the rate increases from east to west. This pattern suggests that sand eroded from the eastern flank and is deposited along the west flank of the barrier as well as in Cat Island Pass (Georgiou et al., 2005). Therefore, longshore drift of sediment placed on Timbalier Island will not likely feed the islands in the Isle Dernieres reach.

Opportunities for ecosystem restoration in the Terrebonne Basin Barrier Shoreline include:

1. Increase the longevity of the barrier island geomorphic form and ecological function
2. Improve the habitat value of the barrier island
3. Increase sediment into the longshore transport process

Opportunity #1: The NER Plan would increase the longevity of the geomorphic form and ecologic function of Raccoon, Whiskey, Trinity, and Timbalier Island by restoring the beach, dune, and marsh components of each island. The minimal dimensions of these components were defined through analysis of historical planforms and storm erosion modeling. Raccoon Plan E, Whiskey Plan C, Trinity Plan C, and Timbalier Plan E maintains these minimal dimensions even after being subjected to a number of design storms (see Section 3.3.2.2.1), plus an addition 5 years of advanced fill for Plan C and 25 years for Plan E. Vegetative plantings, herbivory control, and sand fencing also contribute to restoring the geomorphic form and ecologic function of the island.

Opportunity #2: As previously stated, construction of the NER Plan (with renourishment) will create an additional 2883 AAHUs on the existing island footprints, increasing the total ecosystem habitat benefits of Raccoon, Whiskey, Trinity, and Timbalier Islands to 3558 AAHUs. For the FWOP conditions on Raccoon Island, supratidal and intertidal habitat is expected to disappear by TY30 and TY40, respectively. Supratidal and intertidal habitat on Whiskey Island is expected to disappear by TY17 and TY31, respectively. There is currently no dune habitat on either island. If no action is taken, the dune, supratidal, and intertidal habitat on Trinity Island will disappear by TY20, TY33, and TY40, respectively. Timbalier Island will retain only 2 acres of intertidal habitat at TY50 and will loose all dune and supratidal habitat by TY20 and TY46, respectively. The NER Plan (with renourishment) will create and sustain dune habitat for each island beyond TY40 and supratidal and intertidal habitat beyond the 50-year period of analysis.

Opportunity #3: The achievement of this opportunity was addressed in the discussion of Problem #4. Based on the analysis of existing sediment transport data, it is concluded that after beach fill is placed on Whiskey Island during construction of the NER Plan, some of the losses associated with profile equilibration and background erosion along Whiskey Island will be bypassed across Caillou Bay to feed Raccoon Island. Restoration of Whiskey Island and subsequent longshore transport and bypass to the west will complement the TE-29 and TE-48 projects on Raccoon Island (NRCS, 2007), and will supplement the existing CWPPRA investments.

Efficiency
The NER Plan (with renourishment), was evaluated as a stand-alone alternative in the CE/ICA analysis. The results from the IWR output confirmed that the NER Plan was both cost-effective and a Best Buy.

3.6.5 Sustainability

The LCA TBBSR Study was identified in the LCA 2004 report as a restoration feature that could be implemented in the near-term that addresses the most critical needs of the Louisiana coastline. As indicated in the LCA 2004 report, the design and operation of the LCA TBBSR Study feature would maintain the opportunity for, and support the development of large-scale, long range comprehensive coastal restoration. The Study is synergistic with future restoration by maintaining or restoring the integrity of the estuaries' coastline, upon which all future restoration is dependent. The NER Plan will work in concert with other LCA projects such as BUDMAT, CWPPRA, and CIAP features, in addition to other current and future projects developed under the Louisiana Coastal Comprehensive Plan, to improve the sustainability of the Terrebonne Basin Barrier Shoreline.

As a result of the LCA TBBSR Study, there is a substantial improvement in terms of resource sustainability within the Study area provided by the NER Plan compared to the Future Without Project conditions. While much of the constructed acreage created under the NER Plan will decrease by the end of the period of analysis, the net effect of the plan will be to prevent the loss of Raccoon, Whiskey, Trinity, and Timbalier Islands. If no actions are taken, the remaining habitat acres on Raccoon Island (239) and Whiskey Island (820 acres) is expected to disappear by TY40 and TY31, respectively (i.e. all dune, supratidal, and intertidal habitat will be gone). This includes the existing critical mangrove habitat and the back-barrier marsh created by CWPPRA project TE-48 on Raccoon and TE-50 on Whiskey. The remaining habitat on Trinity Island (673 acres) would disappear by TY40 and only 2 acres of intertidal habitat would remain on Timbalier at TY50.The majority of this loss would be prevented with implementation of the NER Plan. The plan also meets the major restoration objectives of restoring the geomorphic form and ecologic function of the barrier islands and of restoring and improving essential habitats for fish, migratory birds, and other terrestrial and aquatic species for the 50 year period of analysis.

The restoration of the four islands would alter the tidal prism, thereby reducing the formation of any additional tidal passes as well as closing or narrowing existing passes and breaches, protecting and preserving the interior marsh habitats which would quickly erode without the protection of the sand shoreline.

3.6.6 Components

The following sections detail the proposed templates for each of the four island plans in the NER Plan.

3.6.6.1 Whiskey Island Plan C

Whiskey Island Plan C proposes a dune height of +6.4 ft NAVD 88 with a dune crown width of 100 ft. The dune elevation takes into account that there will be approximately 0.4 ft of vertical adjustments (sea level change, subsidence, and compaction) occurring during the first six months after construction. At the end of the six-month period, the dune should reach the design elevation of +6.0 ft NAVD 88. The slopes of the beach and dune are set 60:1 and 30:1 (horizontal to vertical), respectively.

The marsh fill is proposed on the landward side of the dune at an elevation of +2.4 ft NAVD 88. Although the design elevation for the marsh is +1.6 ft NAVD 88, the marsh will be constructed at a higher elevation to account for initial vertical adjustments.

The plan will utilize beach/dune material from the Ship Shoal borrow area and marsh material from Whiskey 3a borrow area. An access channel will be excavated along the northern perimeter of the island to facilitate fill placement during construction. Fill quantities for the initial construction of the dune/beach and marsh components of Whiskey Plan C are 8.3 million and 0.6 mcy, respectively. For the dune area, the material will be pumped from the dredge to the beach. The material will then be worked on the beach by bulldozers and front-end loaders. For the marsh area, the material will be pumped from the offshore borrow site. Containment dikes will be constructed around the perimeter. Sediment for the containment dikes will be dredged from existing material inside the marsh creation area. These operations will be completed in a manner that will minimize turbidity of the water at the dredge site and the discharge site. Figure 3-13 presents the plan view of Whiskey Plan C.

Approximately 18,000 ft of sand fencing will be installed. The sand fences are porous barriers that reduce wind speed along the coast such that sand being transported by the wind accumulates on the downwind side of the fence. The sand fences will promote deposition of windblown sand, create dune features, reduce trampling of existing dunes by beach visitors, and protect vegetative plantings. Vegetative plantings will include a variety of native species. The recommended planting density is no greater than 8-ft centers.

Figure 3-13. Whiskey Island Plan C

3.6.6.2 Trinity Island Plan C

Trinity Plan C proposes a dune height of +6.4 ft NAVD 88 with a dune crown width of 100 ft. The slopes of the beach and dune are set 60:1 and 30:1 (horizontal to vertical), respectively. The marsh fill is proposed on the landward side of the dune at an elevation of +2.5 ft NAVD 88, which is slightly higher than the dune elevation at Whiskey. Due to the existing topography of Trinity Island, the required marsh fill thickness is greater and thus results in a higher compaction rate. As with Whiskey Island, the dune and marsh elevations account for vertical adjustments occurring after the first six months of construction.

Immediately after construction (TY1), the Trinity Plan C will add 585 acres of habitat (dune, intertidal, and supratidal) to the existing 564-acre island footprint, increasing the size of the island to 1,149 acres. This includes 129 acres of dune, 456 acres of supratidal, and 564 acres of intertidal habitat.

Trinity Plan C will utilize beach/dune material from Ship Shoal and marsh material from the Whiskey 3A borrow area. An access channel will be excavated along the northern perimeter of the island to facilitate fill placement during construction. Fill quantities for the dune/beach and marsh components of Trinity Plan C are 3.8 million and 3.8 mcy, respectively. For the dune area, the material will be pumped from the dredge to the beach. The material will then be worked on the beach by bulldozers and front-end loaders. For the marsh area, the material will be pumped from the offshore borrow site. Containment dikes will be constructed around the perimeter. Sediment for the containment dikes will be dredged from existing material inside the marsh creation area. These operations will be completed in a manner that will minimize turbidity of the water at the dredge site and the discharge site. Figure 3-14 presents the plan view of Trinity Plan C.

Approximately 22,500 ft of sand fencing will be installed to promote deposition of windblown sand, create dune features, reduce trampling of existing dunes by beach visitors, and protect vegetative plantings. Vegetative plantings will include a variety of native species. The recommended planting density is no greater than 8-ft centers.

Figure 3-14. Trinity Island Plan C

3.6.6.3 Raccoon Island Plan E with Terminal Groin

Raccoon Plan E proposes a dune height of +7.7 ft NAVD 88 with a dune crown width of 100 ft. The dune elevation is considerably higher than that of Trinity and Whiskey because the plan is design to withstand 25 years of additional back ground erosion rather than just 5 years. Furthermore, the thickness of the 25-year plan (Plan E) results in a higher compaction rate.

The slopes of the beach and dune are set 60:1 and 30:1 (horizontal to vertical), respectively. The marsh fill is proposed on the landward side of the dune at an elevation of +3.7 ft NAVD 88. As with the dune elevation, the marsh elevation is higher than that of Whiskey and Trinity because it is designed withstand a longer duration of background erosion.

Immediately after construction (TY1), the Raccoon Plan E will add 554 acres of habitat (dune, intertidal, and supratidal) to the existing 235-acre island footprint, increasing the size of the island to 789 acres. This includes 63 acres of dune, 688 acres of supratidal, and 38 acres of intertidal habitat.

Eight detached and segmented breakwaters were constructed as part of a CWPPRA project (TE-29) in 1997. The breakwaters were installed to reduce shoreline retreat, promote sediment deposition along the beach, and to protect seabird habitat. Due to the success of the TE-29 breakwaters, eight additional breakwaters were constructed as part of a separate CWPPRA project (TE-48) that was completed in 1997. The breakwaters were installed west of the original breakwaters. TE-48 also included the creation of approximately 60 acres of emergent and intertidal back-barrier marsh.

Raccoon Plan E was designed to complement the intertidal marsh created as part of TE-48. Plan E was also designed to avoid approximately 58 acres of existing mangroves immediately adjacent to and gulfward of TE-48 (Figure 3-15).
A terminal groin will also be constructed as part of Raccoon Island Plan E. The terminal groin will be approximately 1200 ft long and 75 ft wide and will be installed at the western terminus of the template to prevent sediment migration out of the Isle Dernieres system.

Fill quantities for the dune/beach and marsh components of Raccoon Plan E are 5.4 million and 4.6 mcy, respectively. An access channel will be excavated along the northern perimeter of the island to facilitate fill placement during construction. The plan will utilize beach/dune material from Ship Shoal and marsh material from the Raccoon Island TE-48 borrow area. However, the borrow area does not have enough material to construct the marsh in its entirety. Therefore, approximately 2.8 mcy of sand will be dredged from Ship Shoal to provide a base layer for the marsh. The marsh material from the Raccoon Island TE-48 borrow area will be deposited on the sand material to provide an adequate foundation for the marsh.

For the dune area, the material will be pumped from the dredge to the beach. The material will then be worked on the beach by bulldozers and front-end loaders. For the marsh area, the material will be pumped from the offshore borrow site. Containment dikes will be constructed around the perimeter. Sediment for the containment dikes will be dredged from existing material inside the marsh creation area. These operations will be completed in a manner that will minimize turbidity of the water at the dredge site and the discharge site. Figure 3-15 presents the plan view of Raccoon Plan E and the proposed terminal groin.

Approximately 12,200 ft of sand fencing will be installed to promote deposition of windblown sand, create dune features, reduce trampling of existing dunes by beach visitors, and protect vegetative plantings. Vegetative plantings will include a variety of native species. The recommended planting density is no greater than 8-ft centers.

Figure 3-15. Raccoon Island Plan E with Terminal Groin

3.6.6.4 Timbalier Island Plan E

Timbalier Plan E proposes a dune height of +7.1 ft NAVD 88 with a dune crown width of 100 ft. The slopes of the beach and dune are set 60:1 and 30:1 (horizontal to vertical), respectively. The marsh fill is proposed on the landward side of the dune at an elevation of +3.2 ft NAVD 88. As with Raccoon Island Plan E, the elevations of the plan are larger than that of Trinity and Whiskey because it is designed to withstand a longer period of background erosion. Furthermore, the larger plans are thicker and thus exhibit higher compaction rates.

Immediately after construction (TY1), the Timbalier Plan E will add 1675 acres of habitat (dune, intertidal, and supratidal) to the existing 955-acre island footprint, increasing the size of the island to 2,630 acres. This includes 215 acres of dune, 2346 acres of supratidal, and 69 acres of intertidal habitat.

Fill quantities for the dune/beach and marsh components of Timbalier Plan E are 10.7 million and 9.1 mcy, respectively. An access channel will be excavated along the northern perimeter of the island to facilitate fill placement during construction. Timbalier Plan E will utilize beach/dune material from South Pelto and marsh material from Whiskey 3A (marsh material). However, the marsh borrow areas do not have adequate material to construct the marsh in its entirety. Therefore, approximately 8.6 mcy of sand will be dredged from South Pelto, Whiskey 3A (sandy material), and New Cut to provide a base layer for the marsh. The marsh material from Whiskey 3A will be deposited on the sand material to provide an adequate foundation for the marsh.

For the dune area, the material will be pumped from the dredge to the beach. The material will then be worked on the beach by bulldozers and front-end loaders. For the marsh area, the material will be pumped from the offshore borrow site. Containment dikes will be constructed around the perimeter. Sediment for the containment dikes will be dredged from existing material inside the marsh creation area. These operations will be completed in a manner that will minimize turbidity of the water at the dredge site and the discharge site. Figure 3-16 presents the plan view of Timbalier Plan E.

Timbalier Island hosts three oil and gas wells that are operated by Hilcorp Energy Co. Based on recent conversations with Hilcorp, two of the three wells on Timbalier are in the process of being plugged and abandoned and therefore will not require access. The third well, SL 301 #101 is active and was recently refurbished by Hilcorp. There is also a tank battery immediately east of the well that is still in operation. Therefore, an access canal was incorporated into the design of the template to facilitate barge travel from the bayward side of the island to the well and tank battery. The canal is approximately 100 ft wide by 2,000 ft long.

A second access canal will be provided at the western end of the island to facilitate access to an active platform. The platform, which is operated by Phoenix Exploration, serves as a junction point for the Tennessee Pipeline. The access canal is approximately 100 ft wide by 550 ft long.

Approximately 35,500 ft of sand fencing will be installed to promote deposition of windblown sand, create dune features, reduce trampling of existing dunes by beach visitors, and protect vegetative plantings. Vegetative plantings will include a variety of native species. The recommended planting density is no greater than 8-ft centers.

Figure 3-16. Timbalier Island Plan E

3.6.7 Design, Environmental, and Construction Considerations

Project construction will require the hydraulic placement of beach and marsh fill within the Study area. Inclement weather, especially tropical storms, may impact the construction schedule. High seas may impact offshore dredging. Waves and winds from storm events may also move debris, cultural resources, and pipelines on the gulf floor. If during dredging, cultural resources are inadvertently discovered, there could be impacts to the schedule and cost of the project. Additionally, dredge availability may impact the schedule and cost of the project. The project could potentially impact threatened and endangered species as well as species of special interest. Therefore, all construction-related activities will be coordinated with the USFWS as well as LDWF. During the PED process both the mechanics/methodologies and phasing of fill placement will be analyzed and modified with the goal to eliminate or minimize adverse impacts. The project team includes ecologists and wildlife biologists who, in concert with agency scientists, will endeavor to ensure the maintenance of habitat diversity and the stability of a diverse assemblage of species. The primary metrics for this should be species diversity and habitat area, to be evaluated during the monitoring and adaptive management process.

3.6.7.1 Protection of Endangered Species and Species of Special Interest

3.6.7.1.1 West Indian Manatee

The West Indian Manatee, which is protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973, is found within the Study Area. To avoid any impacts to the West Indian Manatee, all contract personnel associated with the Study will be informed of the potential presence of manatees and the need to avoid collisions with manatees, which are protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973. All construction personnel will be required to monitor all water-related activities for the presence of manatee(s). Temporary signs will be posted prior to and during all construction/dredging activities to remind personnel to be observant for manatees during active construction/dredging operations or within vessel movement zones (i.e., work area), and at least one sign will be placed where it is visible to the vessel operator. Siltation barriers, if used by the contractor, will be made of material in which manatees could not become entangled, and will be properly secured per technical specifications provided by the manufacture. If a manatee is sighted within 100 yards of the active work zone, special operating conditions will be implemented, including:

- No operation of moving equipment within 50 ft of a manatee;
- All vessels will operate at no wake/idle speeds within 100 yards of the work area; and

- Siltation barriers, if used, will be monitored and re-secured as necessary.

Once the manatee has left the 100-yard buffer zone around the work area on its own accord, special operating conditions are no longer necessary, but careful observations will resume. Care will also be taken to avoid entrapment of individuals if any structure is to be installed that could be a barrier or impediment to manatee movement

3.6.7.1.2 Piping Plovers

The barrier islands in the NER Plan are designated critical habitat for the piping plover, an endangered species. In order to minimize impacts to this species, the sequencing of island construction will allow these birds to temporarily relocate to suitable habitat within the boundary of the Study. For example, the proposed beach and dune components of Whiskey and Trinity Island will be constructed before the marsh templates. Once the beach and dune are completed on these two islands, the construction will begin on the marsh templates. At that point, the beaches would begin to recover. Raccoon Island, however, would remain undisturbed during sediment placement on Whiskey and Trinity and thus would provide suitable habitat for displaced birds. Furthermore, East Island (which is a continuation of Trinity Island) and East Timbalier (which is adjacent to Timbalier Island) are not part of the proposed restoration efforts and would also provide suitable habitat for the birds during construction. Prey species smothered by dune and beach creating activities would re-colonize in the Study boundary within two years following completion of construction activities (USFWS, 2010a). Therefore, by the time construction activities commence on Raccoon Island, the benthic communities on the Whiskey and Trinity Island beaches should be in the recovery phase.

During the PED phase, the USACE will revisit the construction sequencing to assess the feasibility of staggering the construction of the islands such that only one island is disturbed at any point in time. This will minimize disturbance to the piping plover during construction and maintain an abundance of critical habitat within the immediate vicinity of the disturbed island. By staggering the initial construction of the islands in the NER Plan, the renourishment events would also be staggered. However, constructing the islands in series could significantly delay the completion of the Study.

Formal consultation on the piping plover has been conducted and the USFWS has issued a Biological Opinion (Annex A2). The USACE has agreed to comply with the reasonable and prudent measures (RPM) and the terms and conditions outlined in the Biological Opinion. The following RPMs will be taken to minimize take on non-breeding piping plovers during implementation of the NER Plan:

- A baseline piping plover survey will be conducted within the migrating and wintering season immediately prior to initial construction within the Study Area. As part of that survey, the project footprint should be delineated using a global position system (GPS) unit and appropriately marked/flagged for future survey reference and data collection;

- A survey of the intertidal benthic prey species community shall be conducted within the migrating and wintering season immediately prior to initial construction, at the same time as the plover distribution surveys, in order to establish a baseline of benthic prey species diversity and abundance.
- Piping plover monitoring surveys shall be conducted during the migrating and wintering seasons throughout initial project construction and three consecutive years following completion of initial construction;
- To confirm re-establishment of suitable foraging habitat for migrating and wintering plovers, monitoring surveys of the intertidal benthic prey species community shall be conducted each year following completion of initial construction for three consecutive years, preferably at the same time as the bird surveys;
- The USFWS shall be notified in writing at least 3 months prior to a renourishment event for each island. If renourishment events are conducted during the migrating and wintering season, piping plover monitoring surveys shall be conducted for the duration of construction activities; and
- A comprehensive report describing the actions taken to implement the RPMs and terms and conditions associated with this incidental take statement (including data sheets from surveys conducted) shall be submitted to the USFWS by June 1 of the year following completion of all required surveys.

In order to be exempt from the prohibitions of Section 9 of the Endangered Species Act, the USACE will execute the following terms and conditions.

Requirements for Piping Plover Surveys

- The USACE will conduct a minimum of two surveys per month. If conditions require a deviation from the recommended survey schedule, such information will be carefully documented, including an explanation why any deviation from the recommended schedule was deemed necessary.
- Qualified professionals with shorebird/habitat survey experience will conduct the required survey work. Piping plover monitors will be capable of detecting and recording locations of roosting and foraging plovers, and documenting observations in legible, complete field notes.
- Binoculars, a global positioning system (GPS) unit, a 10-60x spotting scope with a tripod, and the USFWS-approved survey datasheet will be used during monitoring.

- Negative (i.e., no plovers seen) and positive survey data will be recorded and reported.
- Piping plover locations will be recorded with a GPS unit set to record in decimal degrees in universal transverse mercator (UTM) North American Datum 1983 (NAD83).
- Habitat, landscape, and substrate features used by piping plovers when seen will be recorded.
- Behavior of piping plovers (e.g., foraging, roosting, preening, bathing, flying, aggression, walking) will be documented on the USFWS-approved survey data sheet.
- Color-bands seen on piping plovers shall also be carefully documented.

Requirements for Surveying Benthic Prey Species

- A qualified professional with sediment/macroinvertebrate sampling experience will conduct the required benthic prey species surveys.
- A baseline macroinvertebrate survey will be conducted at the same time of the initial piping plover survey during the migrating/wintering season immediately prior to construction. Additional surveys will be conducted during the migrating/wintering season each year post-construction for three consecutive years to determine benthic prey species recovery. Such surveys will be conducted at the same time as the plover surveys.
- Sampling will be conducted using a basic before and after control and impact design method. Sampling will be coordinated with piping plover foraging observations based on low tide surveys.
- In addition to recording benthic species abundance and diversity, a qualitative measure of sediment characteristics (sand, shell, mud) will also be recorded.
- A detailed sampling methodology will be developed in coordination with the USFWS and LDWF prior to initiating surveys.

Reporting Requirements

- All data collected during the surveys will be incorporated into an appropriate database, preferably one for piping plovers and one for benthic prey species.
- Annual update reports will be provided to the USFWS and LDWF by June 30 of each calendar year once construction begins. Annual update reports will include data sheets, maps, a copy of the database, and the progress and initial findings of piping plover and benthic community surveys, as well as any problematic issues that may hinder future survey efforts.

- If the USACE foresees any problematic issues that would require a change in the recommended survey schedule due to work conditions or project delays, the USACE will immediately notify the USFWS to resolve/correct any such issues.
- A final comprehensive report will be provided to the USFWS and LDWF by June 30 following the third year of surveys. That final report will include an analysis of all data results from the piping plover and benthic community surveys.
- At least six months prior to mobilization, the USACE will notify the USFWS in writing prior to each proposed renourishment event. The notification will include whether there are any changes in the proposed amount of renourishment per island.

Upon locating a dead or injured piping plover that may have been harmed or destroyed as a direct or indirect result of the proposed project, the USACE will notifying the USFWS's Lafayette, Louisiana, Field Office (337/291-3100) and the LDWF's Natural Heritage Program (225/765-2821). Care will be taken in handling an injured piping plover to ensure effective treatment or disposition and in handling dead specimens to preserve biological materials in the best possible state for later analysis.

3.6.7.1.3 Sea Turtles

Threatened and endangered sea turtles that could be found in the Study Area include the green sea turtle, hawksbill, Kemp's ridley, leatherback, and loggerhead. Based on professional experience and related CWPPRA project construction methods, it is anticipated that a hydraulic cutterhead dredge and booster pump(s) would be used to excavate sediment from the available offshore borrow area(s) and directly transport it via a submerged sediment pipeline to the islands. It is has been the experience of the USACE that sea turtles are typically able to avoid cutterhead dredge intakes because the dredges move along the seabed at such a slow speed. Sediment used to construct the containment dikes would be dredged from existing material inside the marsh creation area rather than from offshore borrow areas. Therefore, hydraulic cutterhead dredging operations associated with construction of the containment dikes are not expected to adversely impact sea turtles.

3.6.7.1.4 Brown Pelican and Colonial Nesting Birds

The islands included in the NER Plan host a variety of colonial nesting waterbird species, including the brown pelican. These species breed in high densities along the shorelines and barrier islands of Coastal Louisiana. The following section describes the measures that will be used to avoid impacts to brown pelicans and the colonial nesting birds that occupy the Study Area.

Due to the duration of the construction events, avoiding critical nesting periods altogether is not feasible under the current schedule and funding constraints. Therefore, a combination of proactive measures, coordination, monitoring, and avoidance will be utilized to avoid/reduce impacts to these species. Throughout PED, consultation will continue with the LDWF, USFWS, and NMFS on detailed contract specifications to avoid and minimize potential impacts to the brown pelican and colonial nesting waterbirds.

Proactive measures will be taken to prevent brown pelicans and colonial nesting waterbirds from nesting within the Study Area prior to and during construction. These measures may include deterrents such as propane cannons, predator decoys, or other approved bird repellant devices. These repellent devices will be placed in designated areas within the Study Area prior to the nesting periods. Nesting periods are April 2 through September 15 for gulls terns, and/or black skimmers; February 16 through August 31 for nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants; and April 1 through September 14 for brown pelicans. The contractor will coordinate closely with the LDWF, USFWS, and NMFS on the timing and placement of the deterrent devices. The USACE understands the importance of preventing nesting activities within the Study Area that is under constructions as there is no provision for "incidental take" in the Migratory Bird Treaty Act of 1918

Prior to any work, qualified personnel will conduct surveys in all potential nesting bird habitats within the Study boundaries that may be impacted by construction or preconstruction activities. These surveys will be conducted for both brown pelicans and colonial nesting waterbirds. Data collection protocols will be established through close coordination with the LDWF, USFWS, and NMFS.

- Nesting periods are April 2 through September 15 for gulls terns, and/or black skimmers; February 16 through August 31 for nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants; and April 1 through September 14 for brown pelicans.
- Nesting season surveys shall be conducted in all potential nesting bird habitats within the Study boundaries that may be impacted by construction or preconstruction activities during the nesting season. Portions of the Study area in which there is no potential for project-related activity during the nesting season may be excluded.
- Surveys for detecting new nesting activity will be completed on a daily basis prior to movement of equipment, operation of vehicles, or other activities that could potentially disrupt nesting behavior or cause harm to the birds their eggs or young.
- Surveys should be conducted by walking the length of the Study area and visually inspecting, using binoculars or spotting scope, for the presence of shorebirds exhibiting breeding behavior. If an ATV or other vehicle is needed to cover large Study areas, the vehicle must be operated at a speed of <6 mph, shall

be run at or below the high tide line, and the Bird Monitor will stop at no greater than 200-meter intervals to visually inspect for nesting activity.

- Daily summaries of shorebird/brown pelican abundance, location of the birds and their activity (e.g., foraging, resting, nesting, courtship behavior), and summaries of any nests observed including the number of eggs and fledglings, shall be provided on the next business day on an approved report form.
- The Bird Monitor shall communicate the results of their survey to the contractor daily.
- If breeding is confirmed by the presence of a scrape, eggs, or young, the Bird Monitor will immediately notify the appropriate personnel at the LDWF and USFWS.

If nesting occurs during construction within the Study area, the contractor shall establish a 650-ft buffer zone around colonies containing nesting gulls, terns, and/or black skimmers; a 1,000-ft buffer around colonies of nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants; and a 2,000-ft buffer around nesting colonies of brown pelicans.

- The designated buffer zones shall be posted with clearly marked signs around the perimeter. These markings shall be maintained until nesting is completed or terminated. In the case of solitary nesters, nesting is not considered to be completed until all chicks have fledged.
- No construction activities, movement of vehicles, or stockpiling of equipment shall be allowed within the buffer area unless authorized by LDWF, USFWS, and NMFS.
- LDWF/USFWS/NMFS-approved travel corridors shall be designated and marked outside the buffer areas. Heavy equipment, vehicles, and pedestrians may transit past nesting areas in these corridors. However, other activities such as stopping or turning shall be prohibited within the designated travel corridors adjacent to the nesting site.
- Where such a travel corridor must be established within the Study Area, it shall avoid critical areas for shorebirds (known nesting sites, designated critical wildlife habitat, and designated critical piping plover habitat) as much as possible, and be marked with signs clearly delineating the travel corridor from the shorebird buffer areas described above.

If shorebird or pelican nesting occurs within the Study Area, a bulletin board will be placed and maintained in the construction area with the location map of the construction site showing the bird nesting areas and a warning, clearly visible, stating the "bird nesting areas are protected by the Federal Migratory Bird Treaty Act."

3.6.7.1.5 Blue Crabs

The construction and renourishment of the NER Plan will require a total of 46,035,718 cy of fill material from the Ship Shoal borrow area. Ship Shoal possesses a unique benthic meiofaunal and macrofaunal community due to its sandy substrate and water depths. A study by MMS found that the shoal was an important spawning, hatching, and foraging habitat for populations of blue crab. The study also found that actively spawning, hatching, and foraging blue crabs were present in the shoal between April and October, with the highest abundance occurring in August (Condrey and Gelpi, 2010).

The dredging activities occurring during construction and renourishment could potentially impact blue crab communities on Ship Shoal. Direct impacts could include physical disturbance and temporarily loss of spawning, hatching, and foraging habitats due to alterations in water depths, turbidity, and sediment characteristics. Indirect impacts could include the alteration of food web dynamics through the smothering and removal of benthic prey species (Stone et al., 2009).
In order to minimize impacts to the blue crab communities during construction and renourishment, the USACE will take the following precautions:

- Survey blue crab populations within the Ship Shoal disturbance area prior to, during, and after construction of the NER Plan;
- Minimize dredging activities during the spawning, hatching, and foraging season (April through October);
- Minimize the depth of dredging to prevent the formation of hypoxic zones; and
- Phase the dredging activities such that blue crabs will have sufficient habitat adjacent to the disturbance area for relocation.

All dredging activities will be conducted in close coordination with NMFS, USWFS, and LDWL.

3.6.7.2 Beach and Dune Construction

A hydraulic cutterhead dredge would be used to excavate sand from the available sand borrow areas. The sand will then be pumped through a series of booster pumps to the beach/dune fill template via a submerged sediment pipeline.

During construction the contractor will be directed to maintain dedicated equipment loading/unloading areas, staging areas, and access corridors to minimize the impacts to the island. Existing mangrove habitats and prior restoration Study areas shall be avoided by construction equipment and construction-related activities.

Once on the beach, the sediment pipeline would run parallel to the shoreline. Front-end loaders equipped with grapple arms will be utilized in the placement and relocation of the sediment pipeline. For segments of the fill template that have sufficient width, a Y-valve would be utilized to enable placement of multiple sediment pipelines along the template. The bifurcation of the discharge pipeline will facilitate lower discharge velocities and increased sediment retention within the fill template. In order to minimize the impact on piping plover, the beach will be constructed in sections to allow the birds to move to areas that are not currently under construction.

The dredged material would be worked on the beach by bulldozers to meet the specified template grades, slopes and widths. Construction methods may vary but it is anticipated that sand placement along the shoreline will be controlled by advancing a temporary sand dike several hundred ft parallel to shore ahead of the discharge terminus. This aids in reducing initial fill losses offshore and helps control temporary turbidity that may result from the fill placement operations. Typically water drainage and discharges will be directed offshore into the Gulf of Mexico or into existing marsh areas to nourish these habitats.

If construction is completed during the summer, fall, or winter months, the dune and supratidal areas would be temporarily stabilized through aerial dispersion of grass seed. During the first spring following construction, the dune and supratidal areas would be planted with a more permanent combination of plants including bitter panicum (Panicum amarum var amarum 'Fourchon'), sea oats (Uniola paniculata 'Caminada'), marshhay cordgrass (Spartina patens 'Gulf Coast') and gulf cordgrass (Spartina spartinae). Vegetation would be manually planted on 8-ft centers and would provide 100% coverage of the dune and supratidal areas.

An additional 15% of the dune and supratidal swale areas will be planted with woody species in TY2. The vegetation will be manually planted on 8-ft centers. Woody species will include matrimony vine (Lycium barbarum), wax myrtle (Myrica cerifera), iva (Iva imbricata), eastern baccharis (Baccharis halimifolia), and hercules club (Zanthoxylum clava-herculis).

3.6.7.3 Back-Barrier Marsh Construction

As with the beach fill, it is anticipated that a hydraulic cutterhead dredge and booster pump(s) would be used to excavate sediment from the available offshore marsh borrow area(s) and directly transport it via a submerged sediment pipeline to the marsh platform. Sediment used to construct the marsh containment dikes will be dredged from existing material inside the marsh creation area rather than from offshore borrow areas.

Construction operations would be done in a manner that would minimize turbidity. Discharge and dewatering from the marsh fill shall typically be directed towards the Gulf of Mexico including orienting discharge pipes such that the hydraulic flow moves in a gulfward direction and locating dewatering structures on the gulf side of the Study area. The contractor may employ other methods such as building interior containment dikes and creating a drainage gradient towards the gulf. If excess turbidity occurs, the contractor will be directed to change the operating procedure to reduce the degree of turbidity.

Herbaceous planting of the marsh template will be conducted in two phases. The first phase will occur in the second year following construction (i.e. TY3) and will consist of covering 50% of the platform. The remaining 50% of the platform will be planted the following year. The species used for planting will primarily consist of smooth cordgrass (Spartina alterniflora 'Vermilion'). The vegetation will be manually planted on 8-ft centers.

3.6.7.4 Construction Access Considerations

The required land based equipment including but not limited to graders, loaders, dozers, and marsh buggy backhoes will be transported from the mainland to the islands via barge(s). The contractor will excavate access channels from either the Gulf of Mexico or the back bays to the islands utilizing barge mounted clamshell dredges with temporary sidecast disposal. Exact access to the beach/dune and marsh fill templates will be determined and coordinated during the PED phase and will include the necessary easements. The contractor will be required to submit a construction access plan which shall contain provisions for the restoration of any damaged habitats.

Miscellaneous equipment to be stored on the beach may include sediment pipeline, graders, loaders, dozers, marsh buggy backhoes, weirs, grade stakes, light towers, fuel tanks with containment, welding machine, and temporary shanty for personnel. Further, the contractor will locate a quarters barge in an appropriate sheltered staging area to house the land based personnel and office facilities.

3.6.8 Real Estate Requirements

The following sections highlight the real estate considerations for the NER Plan. Additional information is provided in the Real Estate Plan (Appendix J).

3.6.8.1 Land Acquisition

Raccoon Island
Raccoon Island is owned by the State of Louisiana and is valued highly by LDWF because it is the largest pelican rookery in Louisiana, critical habitat for piping plover, and it is frequented by other threatened and endangered species. The island has a footprint which contains approximately 235 acres. Fill for the dune/beach and marsh components will be placed directly into water bottoms owned by the State of Louisiana as well as the upland areas owned by the State. The island is owned by the State of Louisiana and is under the jurisdiction of the Louisiana Department of

Wildlife & Fisheries for Isles Dernieres Barrier Island Refuge; therefore, easements are not needed for this island, only a Grant of Particular Use.

Whiskey Island

Whiskey Island is an uninhabited island off the coast of Terrebonne Parish. Access to the Island is only by boat. The island has a narrow beach area on the Gulf front and broken marsh on the landside. Fill for the dune/beach and marsh components will be placed directly into water bottoms owned by the State of Louisiana as well as the upland areas owned by the State. The island is owned by the State of Louisiana and is under the jurisdiction of the Louisiana Department of Wildlife & Fisheries for Isles Dernieres Barrier Island Refuge; therefore, easements are not needed for this island, only a Grant of Particular Use.

Trinity Island

Trinity Island has a footprint which contains approximately 887 acres. What had been two islands for decades, and rejoined only recently appears to be successfully maintaining itself. Fill for the dune/beach and marsh components will be placed directly into water bottoms owned by the State of Louisiana as well as the upland areas owned by the State and a private entity. The majority of the island is owned by the State of Louisiana. However, a small portion of the island, approximately 30 acres, is privately owned by what appears to be one landowner. A Standard Perpetual Beach Nourishment Easement would be acquired over these 30 acres of private property.

Timbalier Island

Timbalier Island has a footprint which contains approximately 1,087 acres. Existing canals are apparently routinely used to service isolated petroleum production facilities and wells, based on evidence of recent dredging. Active gas production is present on the northern side of the island. Fill for the dune/beach and marsh components will be placed directly into water bottoms owned by the State of Louisiana as well as the upland areas owned by the State and private entities. The majority of the island is owned by the State of Louisiana. However, one end of the island has some private ownership which is estimated to be approximately 80 acres. The ownership of this land is heavily disputed; however, preliminary data indicates that each of the 11 estimated tracts contain multiple owners. A Standard Perpetual Beach Nourishment Easement would be acquired over these 80 acres of private property.

3.6.8.2 Estates

The LDWF owns fee (excluding minerals) for Whiskey Island and Raccoon Island, therefore, the State has sufficient interests to meet the requirements for these two islands. The LDWF also owns fee (excluding minerals) for portions of Trinity Island and Timbalier Island. A Grant of Particular Use (GPU) would be given from the State to USACE for these State-owned areas. The rights delineated in the GPU will be similar to the language in the following standard and non-standard estates: Perpetual Beach Nourishment Easement, Perpetual Restrictive Dune Easement, Temporary Work Area Easement, and a Wetland Creation and Restoration Easement. The acquisition of these specific estates over these areas is not required because the land is owned by the State of Louisiana. Therefore, only administrative costs would apply.

For the private property located on Trinity Island and Timbalier Island, easements would need to be acquired. The estate anticipated to be acquired would be a standard Perpetual Beach Nourishment Easement.

3.6.8.3 Acquisition Costs

Construction and renourishment of the NER Plan will occur on both State owned and private properties; therefore, costs will be incurred associated with obtaining title, mapping and right of entry for construction from the State and private ownerships; as well as appraisals, negotiations, and the actual land costs for the easements over the private property. Costs are estimated to be approximately $692,000 in 2009 dollars (escalated to $715,000 in 2012).

3.6.8.4 Relocation Assistance

The Study does not displace residential, commercial or industrial facilities. Therefore, the provisions of Title II of Public Law 91-646, as amended are not applicable.

3.6.8.5 Mineral Exploration

Throughout the Study area of the NER Plan, several oil and gas pipelines are present. Pipeline crossings occur within the island footprints, between the islands, and within the vicinity of the islands inshore waters. These pipelines are used to transport crude oil and natural gas from wells to facilities scattered throughout the Terrebonne Basin. These lines will be identified, marked and protected during construction and renourishment. The placement of sediment on these lines will pose no adverse impact on the pipelines.

Although the underlying mineral right holders have the right to access the surface of the islands to explore for minerals, it is not likely that they will do so. These islands are part of the Terrebonne Barrier Island Refuge and to conduct mineral explorations on the island would be inconsistent with the protection of wildlife. Louisiana Land and Exploration (LL&E), one of the major underlying mineral right holders, is a large landowner with property throughout south Louisiana. It is important for this company to maintain an image that portrays it as an environmental steward.

In addition, the LDWF has established procedures for granting permits for exploratory activities on its WMAs. These procedures would apply to Whiskey, Raccoon and portions of Trinity/East Islands, as they are part of the Isles Dernieres Barrier Islands Refuge. Below is a list of requirements from the LDWF.

The LDWF requires a request for permit be submitted in writing. A "Conditions of Letter of Permission to Conduct Seismic Activity in the State of Louisiana" form must be signed by the company proposing exploration. If the LDWF grants the permit in accordance with regulations, there are still other actions that must be taken prior to beginning exploration. The seismic company must request a Natural Heritage review and submit a Notification of Beginning of Seismic Exploration form. In addition, the company must hold a public meeting. Additionally, any activity in the wetalnds is regulated by Section 404 of the Clean Water Act under the purview of the USACE.

3.6.9 Operations and Maintenance Considerations

3.6.9.1 Breakwaters and Terminal Groin

The purpose of Operation and Maintenance (O&M) is to allow a project to continue to function. For a structure such as a breakwater or a terminal groin, O&M is required to keep the structure functioning at a certain level to provide the benefits claimed in the analysis.

The breakwaters and terminal groin structural measures were evaluated based on a design life of 20 years. During this time, the structures will be maintained and repaired, if necessary. Based on information obtained through personal communication with NRCS, one of the sixteen TE-29 and TE-48 breakwaters on Raccoon Island had to be repaired because of structural settlement (Personal communication, Loland Broussard of NRCS, Dec, 02, 2009). Otherwise the existing breakwaters have performed and required little to no O&M. Costs for O&M are projected for the applicable measure discussed in Chapter L9.

After 20 years, the effectiveness of the structural measures is projected to substantially diminish because of the sea-level change, subsidence, and barrier island landward migration. Maintenance of the structures to the original design after 20 years will no longer result in the same level of function and benefits as the original structures once provided. In order to make the breakwaters and terminal groin functioning and beneficial after 20 years, the structures will have to be modified and rebuilt which does not qualify as O&M.

Renourishment is also considered to be an O&M activity. Raccoon Plan E will be renourished at TY30 by adding adequate sediment such that the dune and supratidal beach acres would be equivalent to that of a newly constructed Plan B template (i.e. restore a Plan B at TY30). Whiskey Plan C will require two renourishment intervals. The first will occur at TY20 and will include the addition of the same amount of dune and supratidal beach habitat that was originally created in TY1 (i.e. add a Plan C to the template at TY20). The second renourishment interval will occur at TY40 and will include the addition of the same amount of dune and supratidal beach habitat needed to construct a Plan B template. Trinity Plan C will be renourished at TY25 by adding the same amount of dune and supratidal beach habitat that was originally added in TY1 (i.e. add a Plan C to the template at TY20). Timbalier Plan E will be renourished at TY30 by adding adequate sediment such that the dune and supratidal beach habitat acres would be equivalent to the acres of a newly constructed Plan B template (i.e. restore a Plan B at TY30). No additional marsh material will be added to any of the islands. Renourishment is discussed in further detail in Section 3.6.1.

3.6.10 Monitoring Plan and Adaptive Management

The details for post-construction monitoring and adaptive management activities proposed for the NER Plan with estimates of cost and duration are presented in Appendix I.

3.6.11 Effectiveness of the NER Plan in Meeting Goals and Objectives

The barrier island restoration components of the NER Plan would achieve the planning objectives by maximizing the barrier islands ability to provide geomorphic and hydrologic form and ecological function over the 50 year period of analysis as well as improve critical barrier island habitats for fish, migratory birds, and other terrestrial and aquatic species. Sediment would be entered into the system to supplement longshore sediment transport processes along the gulf shoreline by mechanically introducing compatible sediment, and increasing the ability of the restored area to continue to function and provide habitat with minimum continuing intervention.

The NER Plan is the plan that best meets the goal of the 2004 LCA Plan to address critical near-term needs for shoreline restoration for Terrebonne Basin through simulating historical conditions by enlarging the barrier islands (width and dune crest) and reducing the current number of breaches to ensure the continuing geomorphic and hydrologic form and function of the barrier islands. The selection of the NER Plan was based on a thorough review of existing scientific and engineering reports, as well as geospatial, survey, and geotechnical data which reaffirmed that the findings of the Final Programmatic Environmental Impact Statement remain valid.

3.6.12 Effectiveness of NER Plan in Meeting Environmental Operating Principles

The NER Plan is also the plan that best meets the USACE Principles and Guidelines of completeness, effectiveness, efficiency, and acceptability, as well as the Environmental Operating Principles of environmental sustainability, interdependence, balance and synergy, accountability, knowledge, respect, and assessing and mitigating cumulative impacts.

3.6.13 Compensatory Mitigation Measures

No compensatory mitigation is required for this Study. As an ecosystem restoration project, the alternatives were designed to avoid, minimize, and reduce potential adverse environmental impacts. Any incidental temporary impacts that might be incurred during construction would be more than offset by the net habitat value created by the NER Plan.

3.7 First Component of Construction

The NER Plan cannot be constructed within WRDA 2007 authorization. In order to identify a plan that could be constructed within WRDA authorization, the PDT performed separate cost refinements on each island in the NER Plan using MCACES Second Generation (MII). The original contingency was also refined using Crystal Ball. These refinements inflated the costs of the islands, leaving Trinity Island Plan C and Whiskey Island Plan C as the only islands plans that could be constructed within the budget. Consequently, a separate screening process was conducted on the two islands to select the most appropriate island as the first component of construction.

A previous CE/ICA analysis revealed that both islands plans, when analyzed separately, were cost-effective. The plans also proved to be cost-effective when analyzed as a separate alternatives (Alternatives 11 and 12) in the Intermediate Array. The cost-effective analysis was conducted by running the IWR platform on an extended array that included the original ten alternatives plus the two additional alternatives (Figure 3-17). Renourishment was not included in this analysis. Details of the additional IWR analysis are provided in Appendix K.

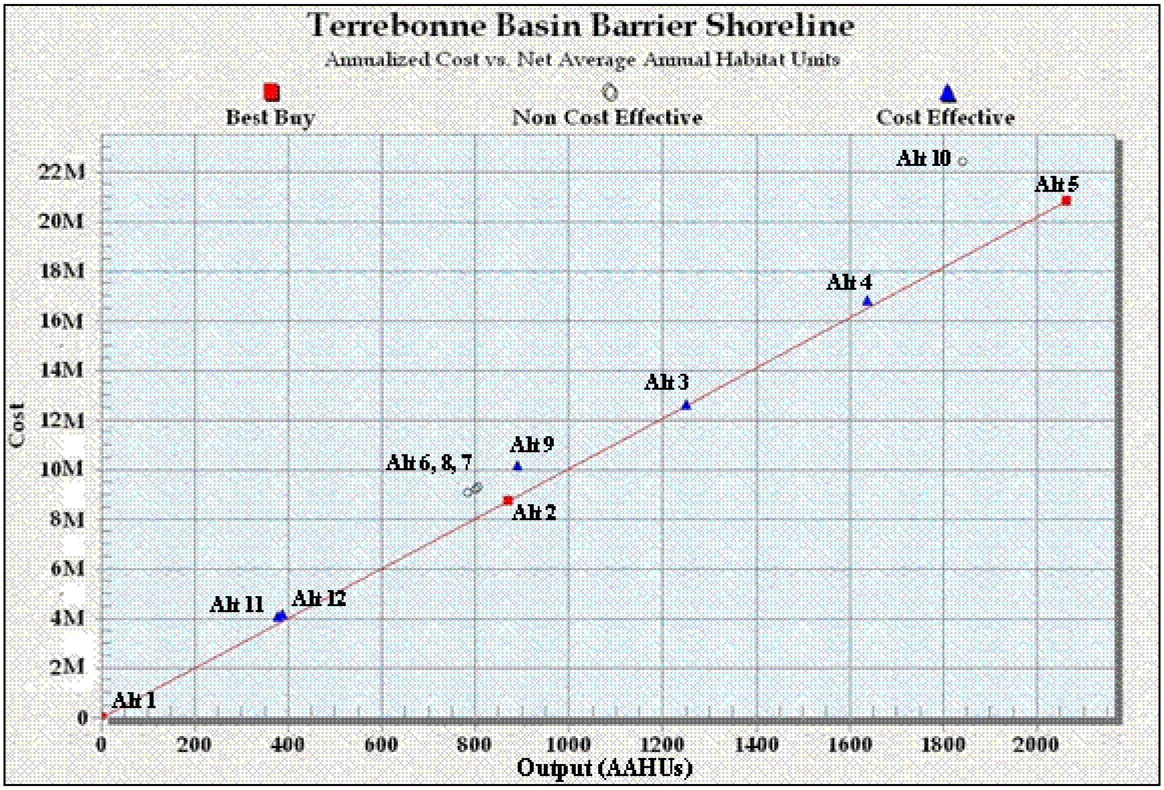

Figure 3-17 CE/ICA including Alternatives 11 and 12

Although Whiskey Plan C provides slightly fewer AAHUs than Trinity Island Plan C (379 net AAHUs vs. 387 net AAHUs), it was determined to be the first component of construction due to a number of qualitative benefits provided by the plan. For example, Whiskey Plan C was designed to avoid approximately 286 acres of existing mangroves on the island in order to minimize the ecologic impact during construction. The plan will restore a total of 1,272 acres of dune, supratidal, and intertidal habitat on the Terrebonne Basin Barrier Shoreline. Since the island is considered a valuable wildlife habitat (Isles Dernieres Barrier Islands Wildlife Refuge) and the LDWF is reestablishing a pelican rookery on the island, maintaining adequate areas of healthy beach, dune, and marsh is particularly important. The island is also a critical habitat for endangered species including the piping plover and is a valuable stopover habitat for migratory birds.

Furthermore, Whiskey Plan C was designed to complement TE-50, which is an existing CWPPRA project that was constructed in 2009. TE-50 created approximately 316 acres of intertidal back-barrier marsh between the two existing mangrove stands. Restoration of the beach and dune gulfward of TE-50 will supplement the existing CWPPRA investment.

The barrier islands provide a critical component of the estuary structure, and are the first line of defense against marine and weather influences. Whiskey Island is the closest of the seven barrier islands to the critical marsh habitat located in the southern-most portion of Terrebonne Parish. If the island were to disappear, the marsh habitat on the mainland would be susceptible to the direct impacts of tropical storms and hurricanes. The implementation of Whiskey Plan C as the first component of construction would also increase sediment available to Raccoon Island because the longshore sediment movement is westward.

As seen in Table 3-19, Whiskey Island is expected to disappear considerably sooner than the other islands in the Isles Dernieres and Timbalier Island Ranges. The island currently lacks dune habitat. If no action is taken on the island, supratidal and intertidal habitat is expected to disappear by TY17 and TY31, respectively (compared to TY33 and TY40 for Trinity Island). Due to the rapidly approaching YOD of the remaining two habitat types, Whiskey Island warrants immediate restoration.

Immediately after construction (TY1), the first component of construction will add 469 acres of habitat (dune, intertidal, and supratidal) to the existing island footprint, increasing the size of the island to 1,272 acres.

Whiskey Plan C is an implementable and separable element of the NER Plan, is cost effective, and is within the cost and scope of the authorization. The non-Federal sponsor fully supports Whiskey Plan C as the first component of construction under the current authorization.

3.7.1 Renourishment

Once the first component of construction was selected, the PDT re-evaluated the feasibility of renourishment on Whiskey Island Plan C. This evaluation was conducted concurrently with that of the NER Plan (see Section 3.6.1). Based on an iterative optimization process, the PDT determined that Whiskey Plan C would require two renourishment intervals. The first would occur at TY20 and would include the addition of the same amount of dune and supratidal beach habitat that was originally created in TY1 (i.e. add a Plan C to the template at TY20). The second renourishment interval would occur at TY 40 and would include the addition of the same amount of dune and supratidal beach habitat needed to construct a Plan B template. No additional marsh material will be added. The resulting habitat acres, including renourishment, are provided in Table 3-36.

Table 3-36. Habitat Acres for Whiskey Plan C (First Component of Construction)– Future With Project (FWP) Conditions

Island	Habitat Type	Habitat Acres – FWP												
		TY0	TY1	TY5	TY10	TY20	TY21	TY25	TY26	TY30	TY31	TY40	TY41	TY50
Whiskey Plan C	Dune	0	65	61	57	0	65	61	61	57	51	0	57	0
	Supratidal	377	830	328	223	84	496	375	344	223	209	84	387	164
	Intertidal	443	377	808	828	847	834	782	769	717	693	472	461	363
	Total	*820*	*1272*	*1197*	*1108*	*931*	*1395*	*1218*	*1174*	*997*	*953*	*556*	*905*	*527*

The WVA Barrier Island Community Model was then used to quantify the additional habitat benefits yielded from the two-interval renourishment plan. The model accounts for the three habitat types, vegetation coverage, interspersion, and surf zone impacts from hard structures. Based on the results of the WVA model, the construction of Whiskey Island Plan C with renourishment at TY20 and TY40 would create an additional 678 AAHUs on the island (compared to 379 AAHUs for Plan C without renourishment), thus increasing the total ecological benefit of the island to 857 AAHUs.

3.7.2 Costs

As previously stated, the PDT performed a separate cost analysis for the first component of construction using the Micro-Computer Aided Cost Estimating System (MCACES), Second Generation (MII). A separate risk analysis was also performed using Crystal Ball software to determine the associated cost uncertainties and derive a cost contingency percentage to be applied to the MII cost estimate for the first component of construction. The resulting fully funded cost of the initial restoration of the first component of construction was $119,000,000. This was within the maximum project cost of $180,900,000 as authorized by WRDA 2007 and modified according to section 902 of WRDA 1986, as amended. A breakdown of the fully funded cost is provided in Table 3-37.

Table 3-37 Fully Funded Cost Summary for the Initial Restoration of the First Component of Construction

Project Element	Fully Funded Total[a]
Lands & Damages	$67,000
Fish & Wildlife (Adaptive Management Plan)	$5,820,000
Beach Replenishment	$103,000,000
PED	$5,040,000
Construction Management	$5,160,000
Initial Restoration Fully Funded Costs	$119,000,000

[a] Includes contingency; Does not include renourishment

Renourishment costs, including two mobilization/demobilization events (one at TY20 and one at TY40) and the cost of dredging the sediment, were later added to the MII to determine the ultimate cost of the first component of construction. Using a total renourishment cost of approximately $342,000,000 ($157,000,000 for the TY20 renourishment and $184,000,000 for the TY40 renourishment), the ultimate cost of the first component of construction with renourishment is $461,000,000. However, renourishment is considered an O&M cost that will be fully-funded by the non-Federal sponsor and does not count toward the maximum project cost of $180,900,000 as authorized by WRDA 2007 and modified according to section 902 of WRDA 1986, as amended.

Despite the increase in cost due to the renourishment intervals, the additional habitat benefits created by the renourishment of Whiskey Plan C resulted in a plan that was still cost-effective when compared to the plans in the Intermediate Array. Table 3-38 illustrates the calculations to determine the maximum cost within WRDA authorization.

Table 3-38 Maximum cost including inflation through the midpoint of construction

Authorized cost in WRDA 2007 Title VII, Section 7006 (e)(3)(A):	$124,600,000
Cost Index Used[a] EM 1110-2-1304 (Revised 31 Mar 2010)	CWBS Feature Code 17 – Beach Replenishment
Cost Index Ratio 1Q FY05 to 1Q FY10	1.22
Current Project Cost Estimate[b] (Inflation applied from 10/2004 to 10/2010)	$151,860,000
20% of Authorized Cost:	$24,920,000
Monitoring & Adaptive Management[c]: (per WRDA 2007 Section 2039)	$5,821,200 - $967,000 = $4,854,200
Maximum Cost Limited by Section 902 B:	$151,860,000 + $24,920,000 + $4,106,600 = $180,886,600 $180,900,000 (R)
Cost without Renourishment[d]	$119,000,000

[a] The cost index applied to the current estimate through PED is derived from: EM 1110-2-1304, 30 Mar 10, Civil Works Construction Cost Index System (CWCCIS)

[b] For the purposes of applying the Cost Index to WRDA Authorized Cost, each project was adjusted for inflation from the October 2004 price levels identified in the 2004 LCA Chief's Report, where the original project budget estimates were developed

[c] Line 2 is the cost of any modifications required by law. This is derived from section 8.0 of each projects Monitoring and Adaptive Management Plan minus the project monitoring cost found on the LCA Cost Summary Worksheet - October 2004 Price Levels modified study cost Dec 20 2004

[d] Renourishment is considered an O&M cost and thus is not included in the maximum cost limited by Section 902 B.

3.7.3 Significance of Ecosystem Outputs

Chapter 2 of ER 1105-2-100 requires plan formulators to consider significant resources and significant effects when comparing and selecting alternatives. Significance of resources and effects are derived from institutional, public, and technical recognition. Resource significance is expanded in Section 4.2.

3.7.3.1 Institutional Significance

Significance based on institutional recognition means that the importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups. The following sections discuss the specific plans, policies, and acts that support the construction of the first component of construction (with renourishment).

Master Plan
Louisiana's Comprehensive Master Plan for a Sustainable Coast (Master Plan) identifies barrier shoreline restoration of Terrebonne Basin as a specific element of the plan (Plan No. 3a-14). This element proposes the use of sediment dredged from offshore sources to reestablish sustainable barrier islands and barrier headlands. The barrier shoreline extends from Bayou Lafourche west to Raccoon Island, and includes the Caminada Headland west of Belle Pass (CPRA, 2007). The construction of Whiskey Island Plan C will directly contribute to the achievement of the State's goal of restoring the Terrebonne Basin barrier shoreline.

CWPPRA
While the Federal government has been concerned with and involved in Louisiana's coastal land loss problem for decades, enactment of CWPPRA in 1990 marked the first Federal statutory mandate for restoration of Louisiana's coastal wetlands. The CWPPRA mandates preparation of an annual Priority Projects List (PPL). These lists consist of projects that address gulf and inland shoreline protection, sediment and freshwater diversions, terracing, vegetative plantings, marsh creation, hydrologic restoration, marsh management, and barrier island restoration.

Two CWPPRA projects have been authorized and constructed on Whiskey Island since 2000: TE-27 and TE-50. The objective of the TE-27 was to close the breach at Coupe Nouvelle and thereby fortify the Gulf shoreline from Coupe Nouvelle to the eastern end of the island. TE-50 was recently constructed to increase the longevity of the previous TE-27 restoration effort by increasing the island's width, providing sand fencing, and stabilizing the restoration efforts with vegetation (LDNR, 2009).
The authorization of the two CWPPRA projects on Whiskey Island proves that there is a need and a desire to restore and maintain the island on both a State and Federal level. Although Whiskey Island Plan C is not a CWPPRA project, it directly contributes to achieving the goals and objectives of CWPPRA by restoring a critical barrier island in the Isle Dernieres Reach.

Endangered Species Act of 1973
The Endangered Species Act of 1973, as amended, requires the designation of critical habitat for all threatened and endangered species. Critical habitat is habitat essential for the conservation or recovery of an endangered or threatened species. In the July, 2001 Final Rule (Federal Register, Vol. 66, No. 132), the USFWS designated Raccoon, Whiskey, Trinity, East, and Timbalier Islands as critical

habitat for wintering populations of the endangered piping plover. The construction of Whiskey Island Plan C will create additional habit for the piping plover and will sustain this habitat beyond the year of disappearance predicted for the FWOP conditions.

Terrebonne Parish Coastal Zone Management Program
One of the specific goals outlined by the Terrebonne Parish Coastal Zone Management (TPCZM) Program is to maintain the integrity of the Isles Dernieres for the protection of interior marshes, local infrastructure, and coastal communities. In order to meet this goal, the CZM developed three policies, one of which is to encourage the use of barrier island restoration practices to maintain or increase island elevation, preventing washover during storms and further deterioration of the islands (TPLCPAC, 2000). The construction Whiskey Island Plan C will increase the width and elevation of the island through the restoration and creation of the beach and dune components. The plan also includes the construction of a back-barrier marsh to catch washover sediment during storm events.

Relationship to USACE Campaign Plan
As previously stated, the second goal of the USACE Campaign Plan is to deliver enduring and essential water resource solutions through collaboration with partners and stakeholders. Although the first component of construction will restore a single island, it achieves this goal because it prolongs the life and restores the habitat value of a critical island (Whiskey Island) in the barrier island system. Restoration of the island is expected to increase storm surge and wave height mitigation, which will assist in Gulf Coast recovery. Because the first component of construction restores the geomorphologic form and ecologic function of the island, it is designed to endure a Katrina/Rita event, an Ike/Gustav event, and a 50-year design storm plus an additional five years of advanced fill. Furthermore, this Study is a collaborative effort between CPRA, USFWS, NOAA, USACE, and public stakeholders.

3.7.3.2 Public Significance

Public recognition indicates that a certain segment of the general public considers the resource significant. The following sections discuss public input in support of the first component of construction (with renourishment).

NEPA Public Scoping Meeting
The USACE published a scoping meeting announcement to request comments regarding the scope of the Terrebonne Basin Barrier Shoreline Restoration Study. The meeting was held on Tuesday, February 10, 2009, in Houma, Louisiana. A total of 74 specific comments were expressed. The comments were categorized according to their applicability to the SEIS. SEIS categories include purpose and need, alternatives, affected environment, environmental consequences and consultation, coordination, and compliance with regulations.

Although there were no specific comments related to Whiskey Island, there were a considerable number of comments that stressed the need to protect the barrier islands in the area: "Our barrier islands are our first line of defense both for storm surge protection and protection of the estuaries. This is the first study that focuses strictly on our barrier island chain from Belle Pass westward over for the Terrebonne and Lafourche or Lafourche Basin barrier island chain and everybody wants this project" (USACE, 2009). Several respondents stressed the urgency of project implementation. The NEPA Scoping Meeting is discussed in greater detail in Section 6.0.

National Audubon Society
The National Audubon Society has designated the Isles Dernieres and Timbalier Islands as Important Bird Areas (IBA). The remote nature of these islands makes them extremely valuable to nesting, wintering, and migrant birds since they are rarely disturbed by anthropogenic activities or large populations of mammalian predators. The National Audubon Society identified coastal erosion and sea level rise as the primary threats to the IBA (National Audubon Society, 2010). The construction Whiskey Island Plan C will help to sustain bird populations in the IBA by creating additional habitat acres for bird populations and by preserving the 286 acres of existing mangrove stands on the island.

3.7.3.3 Technical Significance

Technical recognition of a resource is based on technical criteria. The following sections discuss the technical significance of the first component of construction (with renourishment).

Status and Trends
Simulated erosion of the islands for FWOP conditions reveals that the supratidal and intertidal habitat is expected to disappear by TY17 and TY31, respectively. There is currently no dune habitat on the island. The first component of construction (with renourishment) will create and sustain dune habitat until TY50 and supratidal and intertidal habitat beyond the 50-year period of analysis. By extending the life of each habitat type on the island, the first component of construction is technically significant.

Limiting Habitat
The USFWS designated Whiskey Island as critical habitat for wintering populations of the endangered piping plover. The island also hosts healthy populations of brown pelicans, which were recently removed from the Threatened and Endangered Species List. The construction of Whiskey Island Plan C will create additional habit for the piping plover and brown pelicans and will sustain this habitat beyond the year of disappearance predicted for the FWOP conditions.

Wave Height and Storm Surge Mitigation

In 2003, Stone et al. conducted a pilot study to evaluate the impacts of barrier islands and wetlands deterioration on storm surge and wave energy along the Isles Dernieres and Timbalier Islands. The study compared storm surge elevations and significant wave heights for historic conditions (1950), recent conditions (the 1990s), and anticipated future conditions (2020). When comparing 1950 to 1990, the modeling outputs revealed that the marsh shoreline directly behind the islands experienced a 10-ft increase while the remaining portion of the study area experienced a 6-ft increase in storm surge while. The model also revealed a 4 to 5-ft increase in significant wave height along the marsh shoreline. This considerable increase in storm surge and wave height was directly attributed to the 24% loss of barrier island and marsh landmass that occurred during the period of analysis (1950-1990). The cumulative effects of the increased wave height and storm surge resulted in the inundation of an additional 80,000 acres of landmass within the study area (Stone et al 2003).

Between 1990 and 2020, the model also predicted considerable increases in storm surge elevations and significant wave heights. Storm surge increases of 10 ft to 12 ft (and greater) were found along the bay fringing the marsh north of the Isles Dernieres. The marshes flanking Terrebonne Bay experienced surge increases of 1 to 6 ft. Significant wave height increased by up to 5 ft along the Isles Dernieres and the marsh shoreline behind the islands while increases along Timbalier island ranged from 6 to 8 ft. Due to the collective effects of increased wave height and storm surge elevation, it was predicted that a Class 3 hurricane would inundate an additional 35,000 acres of landmass in 2020 when compared to the 1990s (Stone et al 2003).

The authors of the study concluded that the physical loss of the Isles Dernieres and Terrebonne Islands and associated marshes has resulted and will continue to result in increases storm surge elevations and significant wave heights (Stone et al 2003). Although the authors of the study did not examine the incremental impacts of individual islands on wave height and storm surge mitigation, it can reasonably be inferred that the first component of construction will reduce weather-induced erosion on the marshes north of Whiskey Island.

3.7.4 Acceptability, Completeness, Effectiveness, and Efficiency

Acceptability

The first component of construction is implementable from a technical, environmental, economic, financial, political, legal, institutional, and social perspective. Furthermore, the USACE and CPRA find the plan satisfactory. Therefore, the first component of construction (with renourishment) is acceptable to the Federal sponsor as well as the non-Federal sponsor. The first component of construction was selected by and interagency and interdisciplinary team. The Terrebonne Parish CZM also finds the first component of construction acceptable, although they indicated they would prefer the NER Plan. Input from the public is provided in Appendix G.

Completeness

When selecting the first component of construction, the PDT considered a number of factors beyond its control including real estate, operation and maintenance, monitoring, and sponsorship factors. These factors were considered because of their potential impacts on the realization of the first component of construction.

In order to define property ownership, required estates, and potential relocations, a Real Estate Plan (REP) was developed specifically for the first component of construction (see Appendix J). An Adaptive Management Plan was developed to describe the post-construction monitoring activities proposed for the first component of construction, including costs and duration of the activities (see Appendix I). Operation and Maintenance of the alternatives was considered during plan formulation, particularly for the proposed hard structures (see Section 3.7.9) and renourishment (see Section 3.7.1). Sponsorship factors, particularly related to the non-Federal sponsor, were considered in the analysis (Appendix L). The cost risk analysis also quantifies external risks associated with fuel prices, severe weather downtime, pipeline length, bidder's risk, steel prices, and hurricane demobilizations. Risks and Uncertainties associated with numerical models and relative sea-level rise are discussed in Section 3.8.

Since the above-mentioned external factors and risks were considered during the selection of the first component of construction, the Federal and non-Federal sponsors agree that the plan is complete.

Effectiveness

Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities. The problems that were identified for the Terrebonne Basin Barrier Shoreline include the following:

1. Land loss due to erosion threatens the geomorphic and hydrologic barrier systems
2. Loss of barrier island/headland ecosystem habitat
3. Freshwater wetlands are impacted by increased salinity
4. Longshore sediments are significantly reduced, limiting the ecosystem's ability to be self-sustaining

Problem #1: Land loss will be reversed on Whiskey Island with the construction of the first component of construction. Immediately after construction (TY1), the first component of construction will add 469 acres of habitat (dune, intertidal, and supratidal) to the existing island footprint, increasing the size of the island to 1,272 acres (including dune, intertidal, and supratidal habitat). The dimensions of the island template for Plan C will provide geomorphologic form and ecologic function (as defined in Section 3.3.2.2.1) plus an additional 5 years of advanced fill. The island template is expected to provide incidental wave dampening effects and storm surge mitigation landward of the island. The remaining islands in the Isles Dernieres and Timbalier Island Reaches will continue to erode at their current rate and will provide diminishing protection from waves and storm surge. However, Raccoon Island will benefit from additional sediment due to longshore drift.

Problem #2: Construction of the first component of construction (with renourishment) will create an additional 678 AAHUs on the existing island footprint, increasing the total ecosystem habitat benefits of the island to 857 AAHUs. For the FWOP conditions, supratidal and intertidal habitat is expected to disappear by TY17 and TY31, respectively. There is currently no dune habitat on the island. The first component of construction will create and sustain dune habitat until TY50 and supratidal and intertidal habitat beyond the 50-year period of analysis. Furthermore, the first component of construction is expected to mitigate habitat loss of the mainland directly bay-ward of the island. Habitat loss of the remaining islands in the Isles Dernieres and Timbalier Island Reaches will continue at its current rate (see Table 3-19).

Problem #3: While the first component of construction is expected to create some localized reductions of saltwater intrusion into the freshwater marshes north of Whiskey Island, the benefits of this single island plan will likely be minor when considering the system as a whole. Furthermore, the extent of these benefits is extremely difficult to quantify. To evaluate the role of the islands and their intervening passes in open water circulation and turbulent mixing will require installation of long-term monitoring instruments.

Problem #4: Sediment transport along the Isles Dernieres is complex given its fragmented nature (Georgiou et al., 2005). Within Whiskey Island, longshore sediment transport is bi-directional. Along the east flank of the island net transport is approximately 5,000 cy per year and directed east toward Whiskey Pass. However, net transport along the center of the island is westward toward Caillou Bay and Raccoon Island and increases to approximately 80,000 cy per year (Stone and Zhang, 2001). Toward the west end of Whiskey Island the westerly net transport decreases to approximately 50,000 cy per year. This amount of sediment enters Caillou Bay. Longshore sediment transport on the east end of Raccoon Island is approximately 10,000 cy per year and directed west. Depths within Caillou Bay between Raccoon Island and Whiskey Island range from 4 ft NAVD 88 to 7 ft NAVD 88 and are less than the depth of closure of 10.5 ft NAVD 88. This indicates that this area is within the zone of active sediment transport and up to 10,000 cy per year may be bypassed from Whiskey Island across Caillou Bay to Raccoon Island.

Based on this analysis of existing sediment transport data, it is concluded that after beach fill is placed on Whiskey Island during construction of the first component of construction, some of the losses associated with profile equilibration and background erosion along Whiskey Island will be bypassed across Caillou Bay to feed Raccoon Island. Since Raccoon Island is considered a valuable wildlife habitat along with Whiskey Island (Isles Dernieres Barrier Islands Wildlife Refuge), maintaining adequate areas of healthy beach, dune, and marsh is particularly important. Restoration of Whiskey Island and subsequent longshore transport and bypass to the west will complement the TE-29 and TE-48 projects on Raccoon Island (NRCS, 2007), and will supplement the existing CWPPRA investments.

Opportunities for ecosystem restoration in the Terrebonne Basin Barrier Shoreline include:

1. Increase the longevity of the barrier island geomorphic form and ecological function
2. Improve the habitat value of the barrier island
3. Increase sediment into the longshore transport process

Opportunity #1: The first component of construction increases the longevity the geomorphic form and ecologic function of Whiskey Island by restoring the beach, dune, and marsh components of the island. The minimal dimensions of these components were defined through analysis of historical planforms and storm erosion modeling. Whiskey Island Plan C maintains these minimal dimensions even after being subjected to a number of design storms (see Section 3.3.2.2.1), plus an addition 5 years of advanced fill. Vegetative plantings, herbivory control, and sand fencing also contribute to restoring the geomorphic form and ecologic function of the island.

Opportunity #2: As previously stated, construction of the first component of construction (with renourishment) will create an additional 678 AAHUs on the existing island footprint, increasing the total ecosystem habitat benefits of the island to 857 AAHUs. For the FWOP conditions, supratidal and intertidal habitat is expected to disappear by TY17 and TY31, respectively. There is currently no dune habitat on the island. The first component of construction will create and sustain dune habitat until TY50 and supratidal and intertidal habitat beyond the 50-year period of analysis.

Opportunity #3: The achievement of this opportunity was addressed in the discussion of Problem #4. Based on the analysis of existing sediment transport data, it is concluded that after beach fill is placed on Whiskey Island during construction of the first component of construction, some of the losses associated with profile equilibration and background erosion along Whiskey Island will be bypassed across Caillou Bay to feed Raccoon Island. Restoration of Whiskey Island and subsequent longshore transport and bypass to the west will complement the TE-29 and TE-48 projects on Raccoon Island (NRCS, 2007), and will supplement the existing CWPPRA investments.

Efficiency

The first component of construction, which is a subset of the NER Plan, was evaluated as a stand-alone alternative in the CE/ICA analysis. The results from the IWR output confirmed that the first component of construction was cost-effective.

3.7.5 Sustainability

The LCA TBBSR Study was identified in the LCA 2004 report as a restoration feature that could be implemented in the near-term that addresses the most critical needs of the Louisiana coastline. As indicated in the LCA 2004 report, the design and operation of the LCA TBBSR Study feature would maintain the opportunity for, and support the development of large-scale, long range comprehensive coastal restoration. The Study is synergistic with future restoration by maintaining or restoring the integrity of the estuaries' coastline, upon which all future restoration is dependent. The first component of construction will work in concert with other LCA projects such as BUDMAT, CWPPRA, and CIAP features, in addition to other current and future projects developed under the Louisiana Coastal Comprehensive Plan, to improve the sustainability of the Terrebonne Basin Barrier Shoreline.

As a result of the LCA TBBSR Study, there is a substantial improvement in terms of resource sustainability within the Study area provided under the first component of construction compared to the Future Without Project conditions. While much of the constructed acreage created under the first component of construction will decrease by the end of the period of analysis, the net effect of the plan will be to prevent the loss of Whiskey Island. If no actions are taken, the remaining 820 acres of the island is expected to disappear by TY31 (i.e. all dune, supratidal, and intertidal habitat will be gone). This includes the existing critical mangrove habitat and the back-barrier marsh created by CWPPRA project TE-50. The majority of this loss would be prevented with implementation of the first component of construction. The plan also meets the major restoration objectives of restoring the geomorphic form and ecologic function of the barrier islands and of restoring and improving essential habitats for fish, migratory birds, and other terrestrial and aquatic species for the 50 year period of analysis.

The restoration of the Whiskey Island would alter the tidal prism, thereby reducing the formation of any additional tidal passes as well as closing or narrowing existing passes and breaches, protecting and preserving the interior marsh habitats which would quickly erode without the protection of the sand shoreline.

3.7.6 Components

Whiskey Plan C proposes a dune height of +6.4 ft NAVD 88 with a dune crown width of 100 ft. The dune elevation takes into account that there will be approximately 0.4 ft of vertical adjustments (eustatic sea level rise [ESLR], subsidence, and compaction) occurring during the first six months after construction. At the end of the six-month period, the dune should reach the design elevation of +6.0 ft NAVD 88. The slopes of the beach and dune are set 60:1 and 30:1 (horizontal to vertical), respectively.

The marsh fill is proposed on the landward side of the dune at an elevation of +2.4 ft NAVD 88. Although the design elevation for the marsh is +1.6 ft NAVD 88 (Section 3.3.2.2), the marsh will be constructed at a higher elevation to account for initial vertical adjustments. Immediately after construction (TY1), the first component of construction will add 469 acres of habitat (dune, intertidal, and supratidal) to the existing 803-acre island footprint, increasing the size of the island to 1,272 acres. This includes 65 acres of dune, 830 acres of supratidal, and 377 acres of intertidal habitat.

Whiskey Plan C was designed to avoid approximately 286 acres of existing mangroves on the island to minimize the ecologic impact during construction. Plan C was also designed to complement TE-50, which is an existing CWPPRA project that was constructed in 2009. TE-50 created approximately 316 acres of intertidal back-barrier marsh between the two existing mangrove stands (Figure 3-18).

The first component of construction will utilize beach/dune material from the Ship Shoal borrow area and marsh material from Whiskey 3a borrow area. Fill quantities for the dune/beach and marsh components of Whiskey Plan C are 8.3 million and 0.6 mcy, respectively. For the dune area, the material will be pumped from the dredge to the beach. The material will then be worked on the beach by bulldozers and front-end loaders. For the marsh area, the material will be pumped from the offshore borrow site. Containment dikes will be constructed around the perimeter. Sediment for the containment dikes will be dredged from existing material inside the marsh creation area. These operations will be completed in a manner that will minimize turbidity of the water at the dredge site and the discharge site. Figure 3-18 shows the plan view of Whiskey Plan C.

Approximately 18,000 ft of sand fencing will be installed. The sand fences are porous barriers that reduce wind speed along the coast such that sand being transported by the wind accumulates on the downwind side of the fence. The sand fences will promote deposition of windblown sand, create dune features, reduce trampling of existing dunes by beach visitors, and protect vegetative plantings. Vegetative plantings will include a variety of native species. The recommended planting density is no greater than 8-ft centers.

Figure 3-18. Whiskey Island Plan C

The island will require two renourishment intervals in order to maintain its geomorphologic form and ecologic function throughout the 50-year period of analysis. The first renourishment event will occur 20 years after construction (i.e. 2032) and will include the addition of approximately 8.3 mcy of material to the dune and supratidal beach components of the island. The second renourishment interval will occur 40 years after construction (i.e. TY40) and will include the addition of approximately 6.4 mcy of material to the dune and supratidal beach. No additional marsh material will be added

3.7.7 Design, Environmental, and Construction Considerations

Project construction will require the hydraulic placement of beach and marsh fill within the Study area. Inclement weather, especially tropical storms, may impact the construction schedule. High seas may impact offshore dredging. Waves and winds from storm events may also move debris, cultural resources, and pipelines on the gulf floor. If during dredging, cultural resources are inadvertently discovered, there could be impacts to the schedule and cost of the project. Additionally, dredge availability may impact the schedule and cost of the project. The project could potentially impact threatened and endangered species as well as species of special interest. Therefore, all construction-related activities will be coordinated with the USFWS, NMFS, and LDWF. During the PED process both the mechanics/ methodologies and phasing of fill placement will be analyzed and modified with the goal to eliminate or minimize adverse impacts. The project team includes ecologists and wildlife biologists who, in concert with agency scientists, will endeavor to ensure the maintenance of habitat diversity and the stability of a diverse assemblage of species. The primary metrics for this should be species diversity and habitat area, to be evaluated during the monitoring and adaptive management process.

3.7.7.1 Protection of Endangered Species and Species of Special Interest

3.7.7.1.1 West Indian Manatee

As with the NER Plan, temporary signs will be posted prior to and during all construction/dredging activities to remind personnel to be observant for manatees during active construction/dredging operations or within vessel movement zones (i.e., work area), and at least one sign will be placed where it is visible to the vessel operator. Siltation barriers, if used by the contractor, will be made of material in which manatees could not become entangled, and will be properly secured per technical specifications provided by the manufacture. If a manatee is sighted within 100 yards of the active work zone, special operating conditions will be implemented, including:

- No operation of moving equipment within 50 ft of a manatee
- All vessels will operate at no wake/idle speeds within 100 yards of the work area
- Siltation barriers, if used, will be monitored and re-secured as necessary

Once the manatee has left the 100-yard buffer zone around the work area on its own accord, special operating conditions are no longer necessary, but careful observations will resume. Care will also be taken to avoid entrapment of individuals if any structure is to be installed that could be a barrier or impediment to manatee movement.

3.7.7.1.2 Piping Plovers

As with the NER Plan, beneficial impacts to the piping plover and its critical habitat include the restoration of habitat and prolonged life of Whiskey Island, as well as creating new barriers or structures that would function to protect critical habitat. The implementation of first component of construction would also increase sediment available to Raccoon Island because the long shore sediment movement is westward.

Unavoidable short term impacts to the critical habitat would result from the placement of sediments onto existing beach and dune habitats during construction and renourishment. These activities would smother existing populations of benthic prey species. However, any impacts that would occur to existing designated critical habitat would be temporary, and would provide for the long-term maintenance and/or enhancement of critical habitat within the Study Area. There would be no permanent impacts to critical habitat that would change the ecological processes that maintain it.

Construction of the first component of construction is likely to occur while plovers are present. However, due to their mobility, piping plovers would be able to avoid areas of temporary disturbance using the abundance of suitable foraging and roosting areas adjacent to Whiskey Island. For example, Raccoon, Trinity, East, and Timbalier Islands currently support a total of 1318 acres of critical habitat. East Timbalier Island and Wine Island collectively provide 259 acres of suitable habitat for piping plover, although the islands have not been technically designated as critical habitat. These six islands are located within the immediate vicinity of Whiskey Island.

Formal consultation on the piping plover has been conducted and the USFWS has issued a Biological Opinion (Annex A2). The USACE has agreed to comply with the reasonable and prudent measures (RPM) and the terms and conditions outlined in the Biological Opinion. The following RPMs will be taken to minimize take on non-breeding piping plovers during implementation of the first component of construction:

- A baseline piping plover survey will be conducted within the migrating and wintering season immediately prior to initial construction within the Study Area. As part of that survey, the project footprint should be delineated using a global position system (GPS) unit and appropriately marked/flagged for future survey reference and data collection;

- A survey of the intertidal benthic prey species community shall be conducted within the migrating and wintering season immediately prior to initial construction, at the same time as the plover distribution surveys, in order to establish a baseline of benthic prey species diversity and abundance.
- Piping plover monitoring surveys shall be conducted during the migrating and wintering seasons throughout initial project construction and three consecutive years following completion of initial construction;
- To confirm re-establishment of suitable foraging habitat for migrating and wintering plovers, monitoring surveys of the intertidal benthic prey species community shall be conducted each year following completion of initial construction for three consecutive years, preferably at the same time as the bird surveys;
- The USFWS shall be notified in writing at least 3 months prior to a renourishment event for each island. If renourishment events are conducted during the migrating and wintering season, piping plover monitoring surveys shall be conducted for the duration of construction activities; and
- A comprehensive report describing the actions taken to implement the RPMs and terms and conditions associated with this incidental take statement (including data sheets from surveys conducted) shall be submitted to the USFWS by June 1 of the year following completion of all required surveys.

In order to be exempt from the prohibitions of Section 9 of the Endangered Species Act, the USACE will execute the following terms and conditions.

Requirements for Piping Plover Surveys

- The USACE will conduct a minimum of two surveys per month. If conditions require a deviation from the recommended survey schedule, such information will be carefully documented, including an explanation why any deviation from the recommended schedule was deemed necessary.
- Qualified professionals with shorebird/habitat survey experience will conduct the required survey work. Piping plover monitors will be capable of detecting and recording locations of roosting and foraging plovers, and documenting observations in legible, complete field notes.
- Binoculars, a global positioning system (GPS) unit, a 10-60x spotting scope with a tripod, and the USFWS-approved survey datasheet will be used during monitoring.
- Negative (i.e., no plovers seen) and positive survey data will be recorded and reported.

- Piping plover locations will be recorded with a GPS unit set to record in decimal degrees in universal transverse mercator (UTM) North American Datum 1983 (NAD83).
- Habitat, landscape, and substrate features used by piping plovers when seen will be recorded.
- Behavior of piping plovers (e.g., foraging, roosting, preening, bathing, flying, aggression, walking) will be documented on the USFWS-approved survey data sheet.
- Color-bands seen on piping plovers shall also be carefully documented.

Requirements for Surveying Benthic Prey Species

- A qualified professional with sediment/macroinvertebrate sampling experience will conduct the required benthic prey species surveys.
- A baseline macroinvertebrate survey will be conducted at the same time of the initial piping plover survey during the migrating/wintering season immediately prior to construction. Additional surveys will be conducted during the migrating/wintering season each year post-construction for three consecutive years to determine benthic prey species recovery. Such surveys will be conducted at the same time as the plover surveys.
- Sampling will be conducted using a basic before and after control and impact design method. Sampling will be coordinated with piping plover foraging observations based on low tide surveys.
- In addition to recording benthic species abundance and diversity, a qualitative measure of sediment characteristics (sand, shell, mud) will also be recorded.
- A detailed sampling methodology will be developed in coordination with the USFWS and LDWF prior to initiating surveys.

Reporting Requirements

- All data collected during the surveys will be incorporated into an appropriate database, preferably one for piping plovers and one for benthic prey species.
- Annual update reports will be provided to the USFWS and LDWF by June 30 of each calendar year once construction begins. Annual update reports will include data sheets, maps, a copy of the database, and the progress and initial findings of piping plover and benthic community surveys, as well as any problematic issues that may hinder future survey efforts.

- If the USACE foresees any problematic issues that would require a change in the recommended survey schedule due to work conditions or project delays, the USACE will immediately notify the USFWS to resolve/correct any such issues.
- A final comprehensive report will be provided to the USFWS and LDWF by June 30 following the third year of surveys. That final report will include an analysis of all data results from the piping plover and benthic community surveys.
- At least six months prior to mobilization, the USACE will notify the USFWS in writing prior to each proposed renourishment event. The notification will include whether there are any changes in the proposed amount of renourishment per island.

Upon locating a dead or injured piping plover that may have been harmed or destroyed as a direct or indirect result of the proposed project, the USACE will notifying the USFWS's Lafayette, Louisiana, Field Office (337/291-3100) and the LDWF's Natural Heritage Program (225/765-2821). Care will be taken in handling an injured piping plover to ensure effective treatment or disposition and in handling dead specimens to preserve biological materials in the best possible state for later analysis.

3.7.7.1.3 Sea Turtles

Based on professional experience and related CWPPRA project construction methods, it is anticipated that a hydraulic cutterhead dredge and booster pump(s) would be used to excavate sediment from the available offshore borrow area(s) and directly transport it via a submerged sediment pipeline to the islands. Environmental laws protecting sea turtles could possibly require the cessation of work for a limited time if the allowable number of sea turtles mortalities is exceeded during dredging. However, turtles are typically able to avoid cutterhead dredge intakes because the dredges move along the seabed at such a slow speed. Sediment used to construct the containment dikes would be dredged from existing material inside the marsh creation area rather than from offshore borrow areas. Therefore, hydraulic cutterhead dredging operations associated with the containment dikes are not expected to adversely impact sea turtles.

3.7.7.1.4 Brown Pelican and Colonial Nesting Birds

Whiskey Island hosts a variety of colonial nesting waterbird species, including the brown pelican. These species breed in high densities along the shorelines and barrier islands of Coastal Louisiana. The following section describes the measures that will be used to avoid impacts to these species of special interest that occupy the Study Area during portions of the year.

Due to the duration of the construction events, avoiding critical nesting periods altogether is not feasible under the current schedule and funding constraints.

Therefore, a combination of proactive measures, coordination, monitoring, and avoidance will be utilized to avoid/reduce impacts to these species. Throughout PED, consultation will continue with the LDWF, USFWS, and NMFS on detailed contract specifications to avoid and minimize potential impacts to the brown pelican and colonial nesting waterbirds.

Proactive measures will be taken to prevent brown pelicans and colonial nesting waterbirds from nesting within the Study Area prior to and during construction. These measures may include deterrents such as propane cannons, predator decoys, or other approved bird repellant devices. These repellent devices will be placed in designated areas within the Study Area prior to the nesting periods. Nesting periods are April 2 through September 15 for gulls terns, and/or black skimmers; February 16 through August 31 for nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants; and April 1 through September 14 for brown pelicans. The contractor will coordinate closely with the LDWF, USFWS, and NMFS on the timing and placement of the deterrent devices. The USACE understands the importance of preventing nesting activities within the Study Area that is under constructions as there is no provision for "incidental take" in the Migratory Bird Treaty Act of 1918

Prior to any work, qualified personnel will conduct surveys in all potential nesting bird habitats within the Study boundaries that may be impacted by construction or preconstruction activities. These surveys will be conducted for both brown pelicans and colonial nesting waterbirds. Data collection protocols will be established through close coordination with the LDWF, USFWS, and NMFS.

- Nesting periods are April 2 through September 15 for gulls terns, and/or black skimmers; February 16 through August 31 for nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants; and April 1 through September 14 for brown pelicans.
- Nesting season surveys shall be conducted in all potential nesting bird habitats within the Study boundaries that may be impacted by construction or preconstruction activities during the nesting season. Portions of the Study area in which there is no potential for project-related activity during the nesting season may be excluded.
- Surveys for detecting new nesting activity will be completed on a daily basis prior to movement of equipment, operation of vehicles, or other activities that could potentially disrupt nesting behavior or cause harm to the birds their eggs or young.
- Surveys should be conducted by walking the length of the Study area and visually inspecting, using binoculars or spotting scope, for the presence of

shorebirds exhibiting breeding behavior. If an ATV or other vehicle is needed to cover large Study areas, the vehicle must be operated at a speed of <6 mph, shall be run at or below the high tide line, and the Bird Monitor will stop at no greater than 200-meter intervals to visually inspect for nesting activity.

- Daily summaries of shorebird/brown pelican abundance, location of the birds and their activity (e.g., foraging, resting, nesting, courtship behavior), and summaries of any nests observed including the number of eggs and fledglings, shall be provided on the next business day on an approved report form.

The Bird Monitor shall communicate the results of their survey to the contractor daily.

- If breeding is confirmed by the presence of a scrape, eggs, or young, the Bird Monitor will immediately notify the appropriate personnel at the LDWF and USFWS.

If nesting occurs during construction within the Study area, the contractor shall establish a 650-ft buffer zone around colonies containing nesting gulls, terns, and/or black skimmers; a 1,000-ft buffer around colonies of nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants; and a 2,000-ft buffer around nesting colonies of brown pelicans.

- The designated buffer zones shall be posted with clearly marked signs around the perimeter. These markings shall be maintained until nesting is completed or terminated. In the case of solitary nesters, nesting is not considered to be completed until all chicks have fledged.
- No construction activities, movement of vehicles, or stockpiling of equipment shall be allowed within the buffer area unless authorized by LDWF, USFWS, and NMFS.
- LDWF/USFWS/NMFS-approved travel corridors shall be designated and marked outside the buffer areas. Heavy equipment, vehicles, and pedestrians may transit past nesting areas in these corridors. However, other activities such as stopping or turning shall be prohibited within the designated travel corridors adjacent to the nesting site.
- Where such a travel corridor must be established within the Study Area, it shall avoid critical areas for shorebirds (known nesting sites, designated critical wildlife habitat, and designated critical piping plover habitat) as much as possible, and be marked with signs clearly delineating the travel corridor from the shorebird buffer areas described above.

If shorebird or pelican nesting occurs within the Study Area, a bulletin board will be placed and maintained in the construction area with the location map of the construction site showing the bird nesting areas and a warning, clearly visible, stating the "bird nesting areas are protected by the Federal Migratory Bird Treaty Act."

3.7.7.1.5 Blue Crabs

The construction and renourishment of Whiskey Island Plan C will require a total of 26,012,691 cy of fill material from the Ship Shoal borrow area. Ship Shoal possesses a unique benthic meiofaunal and macrofaunal community due to its sandy substrate and water depths. A study by MMS found that the shoal was an important spawning, hatching, and foraging habitat for populations of blue crab. The study also found that actively spawning, hatching, and foraging blue crabs were present in the shoal between April and October, with the highest abundance occurring in August (Condrey and Gelpi, 2010).

The dredging activities occurring during construction and renourishment could potentially impact blue crab communities on Ship Shoal. Direct impacts could include physical disturbance and temporarily loss of spawning, hatching, and foraging habitats due to alterations in water depths, turbidity, and sediment characteristics. Indirect impacts could include the alteration of food web dynamics through the smothering and removal of benthic prey species (Stone et al., 2009).

In order to minimize impacts to the blue crab communities during construction and renourishment, the USACE will take the following precautions:

- Survey blue crab populations within the Ship Shoal disturbance area prior to, during, and after construction of the NER Plan;
- Minimize dredging activities during the spawning, hatching, and foraging season (April through October);
- Minimize the depth of dredging to prevent the formation of hypoxic zones; and
- Phase the dredging activities such that blue crabs will have sufficient habitat adjacent to the disturbance area for relocation.

All dredging activities will be conducted in close coordination with NMFS, USWFS, and LDWL.

3.7.7.2 Beach and Dune Construction

As previously stated it is anticipated that a hydraulic cutterhead dredge would be used to excavate sand from the available sand borrow areas. The sand will then be pumped through a series of booster pumps to the beach/dune fill template via a submerged sediment pipeline.

During construction the contractor would be directed to maintain dedicated equipment loading/unloading areas, staging areas, and access corridors to minimize the impacts to the island. Existing mangrove habitats and prior restoration project areas shall be avoided by construction equipment and construction-related activities.

Once on the beach, the sediment pipeline will run parallel to the shoreline. Front-end loaders that are equipped with grapple arms would be utilized in the placement and relocation of the sediment pipeline. For segments of the fill template that have sufficient width, a Y-valve would be utilized to enable placement of multiple sediment pipelines along the template. The bifurcation of the discharge pipeline would facilitate lower discharge velocities and increased sediment retention within the fill template. In order to minimize the impact on piping plover, the beach would be constructed in sections to allow the birds to move to areas that are not currently under construction.

The dredge material would be worked on the beach by bulldozers to meet the specified template grades, slopes and widths. Construction methods may vary but it is anticipated that sand placement along the shoreline would be controlled by advancing a temporary sand dike several hundred ft parallel to shore ahead of the discharge terminus. This aids in reducing initial fill losses offshore and helps control temporary turbidity that may result from the fill placement operations. Typically water drainage and discharges would be directed offshore into the Gulf of Mexico or into existing marsh areas to nourish these habitats.

If construction is completed during the summer, fall, or winter months, the dune and supratidal areas would be temporarily stabilized through aerial dispersion of grass seed. During the first spring following construction, the dune and supratidal areas would be planted with a more permanent combination of plants including bitter panicum (Panicum amarum var amarum 'Fourchon'), sea oats (Uniola paniculata 'Caminada'), marshhay cordgrass (Spartina patens 'Gulf Coast') and gulf cordgrass (Spartina spartinae). Vegetation would be manually planted on 8-ft centers and would provide 100% coverage of the dune and supratidal areas.

An additional 15% of the dune and supratidal swale areas will be planted with woody species in TY2. The vegetation will be manually planted on 8-ft centers. Woody species will include matrimony vine (Lycium barbarum), wax myrtle (Myrica cerifera), iva (Iva imbricata), eastern baccharis (Baccharis halimifolia), and hercules club (Zanthoxylum clava-herculis).

3.7.7.3 Back-Barrier Marsh Construction

As with the beach fill, it is anticipated that a hydraulic cutterhead dredge and booster pump(s) would be used to excavate sediment from the available offshore marsh borrow area(s) and directly transport it via a submerged sediment pipeline to the marsh platform. Sediment used to construct the marsh containment dikes will be dredged from existing material inside the marsh creation area rather than from offshore borrow areas.

Construction operations would be done in a manner that would minimize turbidity. Discharge and dewatering from the marsh fill shall typically be directed towards the Gulf of Mexico including orienting discharge pipes such that the hydraulic flow moves in a gulfward direction and locating dewatering structures on the gulf side of the Study area. The contractor may employ other methods such as building interior containment dikes and creating a drainage gradient towards the gulf. If excess turbidity occurs, the contractor will be directed to change the operating procedure to reduce the degree of turbidity.

Herbaceous planting of the marsh template will be conducted in two phases. The first phase will occur in the second year following construction (i.e. TY3) and will consist of covering 50% of the platform. The remaining 50% of the platform will be planted the following year. The species used for planting will primarily consist of smooth cordgrass (Spartina alterniflora 'Vermilion'). The vegetation will be manually planted on 8-ft centers.

3.7.7.4 Construction Access Considerations

The required land based equipment including but not limited to graders, loaders, dozers, and marsh buggy backhoes will be transported from the mainland to the islands via barge(s). The contractor will excavate access channels from either the Gulf of Mexico or the back bays to the islands utilizing barge mounted clamshell dredges with temporary sidecast disposal. Exact access to the beach/dune and marsh fill templates will be determined and coordinated during the PED phase and will include the necessary easements. The contractor will be required to submit a construction access plan which shall contain provisions for the restoration of any damaged habitats.

Miscellaneous equipment to be stored on the beach may include sediment pipeline, graders, loaders, dozers, marsh buggy backhoes, weirs, grade stakes, light towers, fuel tanks with containment, welding machine, and temporary shanty for personnel. Further, the contractor will locate a quarters barge in an appropriate sheltered staging area to house the land based personnel and office facilities.

3.7.8 Real Estate Requirements

The following sections highlight the real estate considerations for the first component of construction plan. Additional information is provided in the Real Estate Plan (Appendix J).

3.7.8.1 Land Acquisition

Whiskey Island is an uninhabited island off the coast of Terrebonne Parish. Access to the Island is only by boat. The island has a narrow beach area on the Gulf front and broken marsh on the landside. Fill for the dune/beach and marsh components will be placed directly into water bottoms owned by the State of Louisiana as well as the upland areas owned by the State. The island is owned by the State of Louisiana and is under the jurisdiction of the Louisiana Department of Wildlife & Fisheries for Isles Dernieres Barrier Island Refuge; therefore, easements are not needed for this island, only a Grant of Particular Use.

3.7.8.2 Estates

The LDWF owns fee (excluding minerals), therefore the State has sufficient interests to meet the requirements of the Study. A Grant of Particular Use (GPU) would be given from the State to USACE. The rights delineated in the GPU will be similar to the language in the following standard estates: Perpetual Beach Nourishment Easement, Perpetual Restrictive Dune Easement, & Temporary Work Area Easement. The acquisition of these specific estates is not required because the land is owned by the Non Federal Sponsor. Therefore, only administrative costs would apply.

Two borrow areas are identified for use. Both are located in the Gulf of Mexico, one identified as Whiskey 3A (48 acres) and is located in within the State waters bottoms of the Gulf of Mexico and the other, Ship Shoal site (560 acres) is located under Federal jurisdiction within the Gulf of Mexico. Therefore, no borrow easement is necessary; the State of Louisiana will issue a Grant of Particular Use (GPU) or a Letter Agreement , such as the sample one shown in Exhibit IV, between governmental agencies to cover project features for the construction of this Study. Appropriate permitting will be obtained from the Mineral Management Service (MMS) prior to dredging operations.

3.7.8.3 Acquisition Costs

The proposed construction and renourishment of the tentatively selected plan will occur entirely on State owned properties; therefore, only minimal administrative costs will be incurred associated with obtaining title, mapping and right of entry for construction from the State. Costs are estimated to be approximately $8,000.

The highest and best use of the property is the same before the project is constructed as after the project is constructed. The project has very nominal impact on the value of the property. Because the real estate interests provided by the State are minor, it is not anticipated at this time, that the non-Federal sponsor will seek credit for providing the land, easements, rights-of-way, relocation, and disposal areas (LERRD). This will be outlined in the Project Partnering Agreement.

3.7.8.4 Relocation Assistance

The Study does not displace residential, commercial or industrial facilities. Therefore, the provisions of Title II of Public Law 91-646, as amended are not applicable.

3.7.8.5 Mineral Exploration

Although LL&E, has the right to access the surface of Whiskey Island to explore for minerals, it is not likely that they will do so. Whiskey Island is part of the Terrebonne Barrier Island Refuge and to conduct mineral explorations on the island would be inconsistent with the protection of wildlife. LL&E is a large landowner with property throughout south Louisiana. It is important for this company to maintain an image that portrays it as an environmental steward. In addition, the LDWF has established procedures for granting permits for exploratory activities on its wetland management areas (WMAs).

3.7.9 Operations and Maintenance Considerations

3.7.9.1 Breakwaters and Terminal Groin

The purpose of Operation and Maintenance (O&M) is to allow a project to continue to function. For a structure such as a breakwater or a terminal groin, O&M is required to keep the structure functioning at a certain level to provide the benefits claimed in the analysis.

There are no hard structures proposed as part of Whiskey Island Plan C. However, Whiskey Plan C will require two renourishment intervals. The first will occur at TY20 and will include the addition of the same amount of dune and supratidal beach habitat that was originally created in TY1 (i.e. add a Plan C to the template at TY20). The second renourishment interval will occur at TY40 and will include the addition of the same amount of dune and supratidal beach habitat needed to construct a Plan B template. Renourishment is discussed in further detail in Section 3.7.1.

3.7.10 Monitoring Plan and Adaptive Management

The details for post-construction monitoring and adaptive management activities proposed for the Study along with estimates of cost and duration are presented in Appendix I.

3.7.11 Effectiveness of the First Component of Construction in Meeting Goals and Objectives

The barrier island restoration components of the first component of construction would achieve the planning objectives by maximizing the barrier islands ability to provide geomorphic and hydrologic form and ecological function over the 50 year period of analysis as well as improve critical barrier island habitats for fish, migratory birds, and other terrestrial and aquatic species. Sediment would be entered into the system to supplement longshore sediment transport processes along the gulf shoreline by mechanically introducing compatible sediment, and increasing the ability of the restored area to continue to function and provide habitat with minimum continuing intervention.

The first component of construction is the plan within the 2007 WRDA authorization that best meets the goal of the 2004 LCA Plan to address critical near-term needs for shoreline restoration for Terrebonne Basin through simulating historical conditions by enlarging the barrier islands (width and dune crest) and reducing the current number of breaches to ensure the continuing geomorphic and hydrologic form and function of the barrier islands. The selection of the first component of construction was based on a thorough review of existing scientific and engineering reports, as well as geospatial, survey, and geotechnical data which reaffirmed that the findings of the Final Programmatic Environmental Impact Statement remain valid.

3.7.12 Effectiveness of First Component of Construction in Meeting Environmental Operating Principles

The first component of construction is also the plan within the 2007 WRDA authorization that best meets the USACE Principles and Guidelines of completeness, effectiveness, efficiency, and acceptability, as well as the Environmental Operating Principles of environmental sustainability, interdependence, balance and synergy, accountability, knowledge, respect, and assessing and mitigating cumulative impacts.

3.7.13 Compensatory Mitigation Measures

No compensatory mitigation is required for this Study. As an ecosystem restoration project, the alternatives were designed to avoid environmental impacts. Any incidental temporary impacts that might be incurred during construction will be more than offset by the net habitat value created by the first component of construction.

3.8 Final Array Impacts

The renourishment cycles that were developed for the NER Plan and the first component of construction were applied to the other alternatives in the final array in order to quantify direct and indirect impacts. Island and borrow area impacts caused by the initial construction and renourishment of the Final Array are summarized in Table 3-39. Temporal distributions of habitat acreages and the resulting AAHUs for each alternative are provided in Tables 3-40 through 3-44.

Table 3-45 presents a comparison of the impacts of each of the alternatives in the Final Array on the significant resources within the Study Area. These significant resources are defined in Section 4 and further analyzed in Section 5.

Table 3-39: Island and Borrow Area Impacts of the Final Array

Alternative	Island Plan	Area Restored at TY1 (acres)	Area Created at TY1 (acres)	Total Area Impacted at TY1 (acres)	Net Area at TY50 (acres)	Net AAHUs	Total Fill Volume[a] (cy)	Total Cut Volume[a] (cy)	Borrow Area Footprint[a] (acres)	Excavated Access Channel Footprint[b] (acres)	Northern Containment Dike Footprint[c] (acres)
Alternative 5 (NER Plan)	Raccoon w/ TG Plan E	235	554	789	641	477	11,937,877	13,803,647	675	29	66
	Whiskey Plan C	803	469	1,272	527	678	23,599,804	26,940,249	1,394	13	23
	Trinity Plan C	564	585	1,149	289	628	11,400,695	14,656,060	758	59	117
	Timbalier Plan E	955	1,675	2,630	1324	1100	20,246,338	24,027,311	894	81	162
	Total	2,557	3,283	5,840	2781	2883	67,184,714	79,427,267	3,721	182	368
Alternative 11	Whiskey Plan C	803	469	1,272	527	678	23,599,804	26,940,249	1,394	13	23
Alternative 2	Timbalier Plan E	955	1,675	2,630	1324	1100	20,246,338	25,746,132	1,035	81	162
Alternative 3	Whiskey Plan C	803	469	1,272	527	678	23,599,804	26,766,332	1,385	13	23
	Timbalier Plan E	955	1,675	2,630	1324	1100	20,246,338	25,746,132	1,035	81	162
	Total	1,758	2,144	3,902	1851	1778	43,846,142	52,512,464	2,420	94	185
Alternative 4	Whiskey Plan C	803	469	1,272	527	678	23,599,804	26,766,332	1,385	13	23
	Trinity Plan C	564	585	1,149	289	628	11,400,695	13,472,599	686	59	117
	Timbalier Plan E	955	1,675	2,630	1324	1100	20,246,338	25,746,132	1,035	81	162
	Total	2,322	2,729	5,051	2140	2406	55,246,837	65,985,063	3,106	153	302

[a] Includes renourishment
[b] All material dredged from the access channel will be used to create the northern containment dike.
[c] The northern containment dike separates the marsh fill from the bay. This footprint is accounted for in the overall island footprint

Table 3-40: Habitat Acres for Alternative 5 (NER Plan)

	Habitat Type	Habitat Acres													AAHUs
		TY0	TY1	TY5	TY10	TY20	TY21	TY25	TY26	TY30	TY31	TY40	TY41	TY50	
FWOP	Dune	95	85	39	12	0	0	0	0	0	0	0	0	0	675
	Supratidal	1209	1152	1018	419	141	131	89	79	37	34	1	1	0	
	Intertidal	1315	1319	1227	1389	961	927	791	757	622	572	122	112	21	
	Total	*2619*	*2557*	*2284*	*1820*	*1102*	*1058*	*881*	*836*	*659*	*605*	*123*	*113*	*21*	
FWP	Dune	95	472	416	313	20	83	71	198	179	364	62	113	3	3558
	Supratidal	1209	4320	3579	3282	2920	3129	2193	2385	1354	1391	1003	1264	660	
	Intertidal	1315	1048	1550	1577	1556	1694	2244	2373	2892	2849	2461	2427	2118	
	Total	*2619*	*5840*	*5545*	*5172*	*4496*	*4905*	*4508*	*4956*	*4425*	*4604*	*3526*	*3803*	*2781*	
Net[a]	Dune	0	387	377	301	20	83	71	198	179	364	62	113	3	2883
	Supratidal	0	3168	2561	2863	2779	2998	2104	2306	1317	1357	1002	1263	660	
	Intertidal	0	-271	323	189	595	766	1452	1616	2271	2277	2339	2315	2097	
	Total	*0*	*3283*	*3261*	*3352*	*3394*	*3847*	*3628*	*4120*	*3766*	*3999*	*3402*	*3690*	*2760*	

[a] Net habitat acres = FWP habitat acres – FWOP habitat acres

Table 3-41: Habitat Acres for Alternative 11

	Habitat Type	Habitat Acres													AAHUs
		TY0	TY1	TY5	TY10	TY20	TY21	TY25	TY26	TY30	TY31	TY40	TY41	TY50	
FWOP	Dune	0	0	0	0	0	0	0	0	0	0	0	0	0	179
	Supratidal	377	367	389	5	0	0	0	0	0	0	0	0	0	
	Intertidal	443	436	345	640	476	466	426	416	375	338	0	0	0	
	Total	*820*	*803*	*734*	*645*	*476*	*466*	*426*	*416*	*375*	*338*	*0*	*0*	*0*	
FWP	Dune	0	65	61	57	0	65	61	61	57	51	0	57	0	857
	Supratidal	377	830	328	223	84	496	375	344	223	209	84	387	164	
	Intertidal	443	377	808	828	847	834	782	769	717	693	472	461	363	
	Total	*820*	*1272*	*1197*	*1108*	*931*	*1395*	*1218*	*1174*	*997*	*953*	*556*	*905*	*527*	
Net[a]	Dune	0	65	61	57	0	65	61	61	57	51	0	57	0	678
	Supratidal	0	464	-61	218	84	496	375	344	223	209	84	387	164	
	Intertidal	0	-59	463	188	371	368	356	353	342	355	472	461	363	
	Total	*0*	*469*	*463*	*463*	*455*	*929*	*792*	*758*	*622*	*615*	*556*	*905*	*527*	

[a] Net habitat acres = FWP habitat acres – FWOP habitat acres

Table 3-42: Habitat Acres for Alternative 2

	Habitat Type	Habitat Acres													AAHUs
		TY0	TY1	TY5	TY10	TY20	TY21	TY25	TY26	TY30	TY31	TY40	TY41	TY50	
FWOP	Dune	57	53	33	9	0	0	0	0	0	0	0	0	0	336
	Supratidal	549	529	457	339	132	122	84	74	36	32	1	1	0	
	Intertidal	374	373	397	364	278	266	218	206	158	149	71	65	13	
	Total	*979*	*955*	*887*	*712*	*409*	*388*	*301*	*280*	*194*	*181*	*73*	*67*	*13*	
FWP	Dune	57	215	183	160	0	0	0	0	0	155	13	12	0	1436
	Supratidal	549	2346	2257	2130	1996	1859	1313	1176	629	667	524	495	236	
	Intertidal	374	69	71	74	76	183	612	719	1148	1146	1123	1120	1088	
	Total	*979*	*2630*	*2511*	*2364*	*2072*	*2043*	*1925*	*1895*	*1777*	*1968*	*1660*	*1626*	*1324*	
Net[a]	Dune	0	162	151	151	0	0	0	0	0	155	13	12	0	1100
	Supratidal	0	1817	1800	1791	1864	1737	1229	1102	593	635	523	494	236	
	Intertidal	0	-304	-326	-290	-202	-83	394	513	990	996	1052	1054	1075	
	Total	*0*	*1675*	*1624*	*1652*	*1663*	*1655*	*1623*	*1615*	*1584*	*1786*	*1588*	*1560*	*1311*	

[a] Net habitat acres = FWP habitat acres – FWOP habitat acres

Table 3-43: Habitat Acres for Alternative 3

	Habitat Type	Habitat Acres													AAHUs
		TY0	TY1	TY5	TY10	TY20	TY21	TY25	TY26	TY30	TY31	TY40	TY41	TY50	
FWOP	Dune	57	53	33	9	0	0	0	0	0	0	0	0	0	515
	Supratidal	926	896	846	344	132	122	84	74	36	32	1	1	0	
	Intertidal	817	809	742	1004	754	732	644	622	533	487	71	65	13	
	Total	*1799*	*1758*	*1621*	*1357*	*885*	*854*	*727*	*696*	*569*	*519*	*73*	*67*	*13*	
FWP	Dune	57	280	244	217	0	65	61	61	57	206	13	69	0	2293
	Supratidal	926	3176	2585	2353	2080	2355	1688	1520	852	876	608	882	400	
	Intertidal	817	446	879	902	923	1017	1394	1488	1865	1839	1595	1581	1451	
	Total	*1799*	*3902*	*3708*	*3472*	*3003*	*3438*	*3143*	*3069*	*2774*	*2921*	*2216*	*2531*	*1851*	
Net[a]	Dune	0	227	212	208	0	65	61	61	57	206	13	69	0	1778
	Supratidal	0	2281	1739	2009	1948	2233	1604	1446	816	844	607	881	400	
	Intertidal	0	-363	137	-102	169	285	750	866	1332	1351	1524	1515	1438	
	Total	*0*	*2144*	*2087*	*2115*	*2118*	*2584*	*2415*	*2373*	*2206*	*2401*	*2144*	*2465*	*1838*	

[a] Net habitat acres = FWP habitat acres – FWOP habitat acres

Table 3-44: Habitat Acres for Alternative 4

	Habitat Type	Habitat Acres													AAHUs
		TY0	TY1	TY5	TY10	TY20	TY21	TY25	TY26	TY30	TY31	TY40	TY41	TY50	
FWOP	Dune	96	85	40	12	0	0	0	0	0	0	0	0	0	631
	Supratidal	1158	1102	988	405	135	125	86	76	38	33	1	1	0	
	Intertidal	1128	1135	1063	1247	868	837	715	684	560	513	84	77	21	
	Total	*2381*	*2322*	*2091*	*1663*	*1002*	*962*	*800*	*760*	*598*	*546*	*86*	*79*	*21*	
FWP	Dune	96	409	366	284	0	65	61	190	179	319	47	99	0	3037
	Supratidal	1158	3632	2901	2623	2270	2525	1778	2016	1172	1187	838	1098	490	
	Intertidal	1128	1010	1511	1537	1517	1612	1991	2078	2426	2382	1975	1943	1650	
	Total	2381	5051	4778	4444	3787	4203	3830	4284	3777	3888	2860	3139	2140	
Net[a]	Dune	0	324	328	272	0	65	61	190	179	319	47	99	0	2406
	Supratidal	0	2531	1913	2219	2135	2400	1692	1940	1134	1154	837	1097	490	
	Intertidal	0	-125	448	290	649	774	1276	1394	1866	1868	1892	1865	1629	
	Total	*0*	*2729*	*2687*	*2781*	*2785*	*3240*	*3029*	*3524*	*3180*	*3341*	*2775*	*3061*	*2119*	

[a] Net habitat acres = FWP habitat acres – FWOP habitat acres

Table 3-45: Comparison of Costs, Benefits, Impacts, and Effectiveness of Each Alternative in the Final Array

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
A. Costs						
Preliminary Costs	$0	$408,000,000	$79,600,000	$170,000,000	$247,000,000	$329,000,000
Annualized Preliminary Costs	$0	$20,830,000	$4,070,000	$8,710,000	$12,640,000	$16,820,000
Fully-funded Project Costs without Renourishment[a]	$0	$689,000,000	$119,000,000	NA	NA	NA
Fully-funded Project Costs with Renourishment[a]	$0	$1,246,000,000	$461,000,000	NA	NA	NA
Cost Effective/ Best Buy	Best Buy	Best Buy	Cost Effective	Best Buy	Best Buy	Best Buy
B. Benefits						
Net AAHUs without Renourishment	0	2063	379	871	1250	1637
Net AAHUs with Renourishment	0	2883	678	1100	1778	2406
C. Impacts to Significant Resources						
Soil	Loss of 3,220 acres of existing barrier soil resources from the seven islands (Raccoon, Whiskey, Trinity, East, Wine, Timbalier, East Timbalier Island) over 50-year period of analysis.	Restore net total of 2781 acres of soils over 50-year period of analysis	Restore net total of 527 acres of soils over 50-year period of analysis	Restore net total of 1,324 acres of soils over 50-year period of analysis	Restore net total of 1,851 acres of soils over 50-year period of analysis	Restore net total of 2140 acres of soils over 50-year period of analysis

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Water bottoms	Conversion of approximately 3,220 acres of existing Terrebonne Basin barrier island beach, dune and marsh habitats to water bottoms.	Initial construction would remove a total of 55,787,481 cy of borrow material from a total of 2498 acres of water bottoms in the offshore borrow areas. Renourishment would remove a total of 23,639,786 cy from a total of 1,222 acres of water bottoms in offshore borrow areas. Initial construction would cover a total of 3,283 acres of water bottoms and existing fragmented barrier habitats. Renourishment would directly cover 71 acres on Raccoon, 474 acres at TY 20 and 349 acres at TY40 on Whiskey Island; 537 acres on Trinity Island at TY 25; and 202 acres on Timbalier Island at TY30.	Initial construction would remove a total of 10,340,701 cy of sediments from a total of 535 acres of borrow site water. Renourishment would remove a total of 16,599,548 cy of borrow material from a total of 859 acres of water bottoms. Initial construction would cover approximately 469 acres of water bottoms and fragmented barrier habitats. Renourishment with borrow material from Ship Shoal – 7 would directly impact a total of 474 acres and 349 acres of water bottoms and fragmented barrier habitats at TY20 and TY40, respectively	Initial construction would remove a total of 25,214,803 cy of sediments from a total of 1,375 acres of borrow site water bottoms including. Renourshiment at TY30 would remove a total of 531,329 cy of borrow material from a total of 26 acres of water bottoms. Initial construction would cover approximately 1,675 acres of existing water bottoms and fragmented barrier habitats. Renourishment at TY30, with borrow material from South Pelto – 6, would directly impact a total of 202 acres of water bottoms and fragmented barrier habitats	Initial construction would remove a total of 35,381,587 cy of borrow material from a total of 1,535 acres of water bottoms in the offshore borrow areas. Renourishment would remove a total of 17,130,877 cy from a total of 885 acres of water bottoms in offshore borrow areas. Initial construction would cover a total of 2,144 acres of water bottoms and existing fragmented barrier habitats. Renourishment would directly cover 474 acres at TY 20 and 349 acres at TY30 on Whiskey Island and 202 acres on Timbalier Island at TY40	Initial construction would remove a total of 44,544,496 cy of borrow material from a total of 1,998 acres of water bottoms in the offshore borrow areas. Renourishment would remove a total of 21,440,567 cy from a total of 1,108 acres of water bottoms in offshore borrow areas. Initial construction would cover a total of 2,729 acres of water bottoms and existing fragmented barrier habitats. Renourishment would directly cover 474 acres at TY 20 and 349 acres at TY40 on Whiskey Island; 537 acres on Trinity Island at TY 25; and 202 acres on Timbalier Island at TY30.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Flow and Water Levels	As barrier land loss and channelization continues, hydrologic connections between the gulf and interior areas increase and exacerbate interior land loss and conversion of habitat types. Continued loss of barrier systems result in reduction and eventual loss of the natural protective storm buffering of these barrier systems	The restoration of a total of 5,840 acres on Raccoon, Timbalier, Trinity, and Whiskey Islands would restore these barrier islands to their minimal geormorphological form thereby enabling these barrier islands to absorb wave energy during storms and fair-weather conditions and provide some storm surge protection for the interior marshes within the basin, which would decrease land loss erosion rates.	The direct impacts to coastal processes, flows and water levels of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), but to a much lesser degree. Alternative 11 would restore the geomorphologic form and ecological function to Whiskey Island resulting in an initial island of 1,272 acres.	The direct impacts to coastal processes, flows and water levels of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan), but to a much lesser degree. Alternative 2 would restore the geomorphologic form and ecological function to Timbalier Island resulting in an initial island of 2,630 acres	The direct impacts to coastal processes, flows and water levels of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan), but to a much lesser degree. Alternative 3 would initially restore the geomorphologic form and ecological function to a 1,272-acre Whiskey Island and 2,630-acre Timbalier Island.	The direct impacts to coastal processes, flows and water levels of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan), but to a lesser degree. Alternative 4 would initially restore the geomorphologic form and ecological function to a 1,272-acre Whiskey Island, 1,149-acre Trinity Island and 2,630-acre Timbalier Island.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Sediment and Erosion	Since there is little-to-no sediment supply, for the No-Action Alternative, approximately 3,220 acres of existing barrier sediment resources from the seven island Terrebonne Basin barrier system (East Timbalier, Timbalier, Trinity, East Island, Wine, Whiskey and Raccoon Island) would likely continue to erode similar to historic erosion rates and eventually convert into shallow open water bottoms. Sediments eroded from these barrier islands would be lost offshore.	A portion of the total 67,184,714 cy of borrow sediments placed for restoration of the four barrier islands would be redistributed, via natural coastal longshore transport process, throughout the Terrebonne barrier island system over the 50-year period of analysis. The proposed terminal groin, as well as the existing segmented breakwaters, on Raccoon Island would function to intercept the net longshore sediment flux, thereby retaining sediments on the beach up-drift of the groin and within the tombolos shoreward of the breakwaters. Sedimentation rates along Whiskey, Trinity and Timbalier Islands would likely remain unchanged.	The impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER) but to a lesser degree, including the natural redistribution of a portion of the total 23,599,804 cy of sediments throughout the Terrebonne Basin barrier island system over the 50-year period of analysis.	The impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER) but to a lesser degree, including the natural redistribution of a portion of the total 20,246,338 cy of sediments throughout the Terrebonne Basin barrier island system over the 50-year period of analysis.	The impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER) but to a lesser degree, including the natural redistribution of a portion of the total 43,846,142 cy of sediments throughout the Terrebonne Basin barrier island system over the 50-year period of analysis.	The impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity, and Timbalier Islands components of Alternative 5 (NER) but to a lesser degree, including the natural redistribution of a portion of the total 55,246,837 cy of sediments throughout the Terrebonne Basin barrier island system over the 50-year period of analysis.
Water Use and Supply	There are no water supply facilities within the Study Area.	Impacts similar to the No Action Alternative.	Impacts similar to the No Action Alternative.	Impacts similar to the No Action Alternative.	Impacts similar to the No Action Alternative.	Impacts similar to the No Action Alternative.
Groundwater	The No Action Alternative would not cause or contribute to any impacts to groundwater.	Impacts similar to the No Action Alternative.	Impacts similar to the No Action Alternative.	Impacts similar to the No Action Alternative.	Impacts similar to the No Action Alternative.	Impacts similar to the No Action Alternative.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Water Quality	Without action, the Terrebonne Basin would still be affected by natural and anthropogenic activities having both beneficial and detrimental effects to water quality. Some of these activities include: other restoration efforts, water quality management programs, programs addressing hypoxia in the northern Gulf of Mexico, the continuation of erosion and subsidence of coastal Louisiana; oil and gas development, and flood-damage reduction and navigation projects.	The direct impacts of implementing Alternative 5 (NER Plan) would primarily result from the discharge of 67,184,714 cy of dredged material and associated effluent waters during construction. Proposed restoration features would not result in either long-term or short-term water quality impacts to the adjacent aquatic ecosystem. Potential impacts of dredged material effluent discharges would include increased turbidity and decreased oxygen concentrations, are expected to be short-lived and would likely result in temporary and minor impacts to water quality, if any.	The direct impacts water quality of implementing Alternative 11 would be similar, but to a much lesser degree, to those described for the Whiskey Island component of Alternative 5 (NER Plan). The discharge of 23,599,804 cy of dredged material and associated effluent waters during construction would include increased turbidity and decreased oxygen concentrations, which are expected to be short-lived and would likely result in temporary and minor impacts to water quality, if any.	The direct impacts water quality of implementing Alternative 2 would be similar, but to a much lesser degree, to those described for the Timbalier Island component of Alternative 5 (NER Plan). The discharge of 20,246,338 cy of dredged material and associated effluent waters during construction would include increased turbidity and decreased oxygen concentrations, which are expected to be short-lived and would likely result in temporary and minor impacts to water quality, if any.	The direct impacts water quality of implementing Alternative 3 would be similar, but to a much lesser degree, to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan). The discharge of 43,846,142 cy of dredged material and associated effluent waters during construction would include increased turbidity and decreased oxygen concentrations, which are expected to be short-lived and would likely result in temporary and minor impacts to water quality, if any.	The direct impacts water quality of implementing Alternative 4 would be similar, but to a lesser degree, to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan). The discharge of 55,246,837 cy of dredged material and associated effluent waters during construction would include increased turbidity and decreased oxygen concentrations, which are expected to be short-lived and would likely result in temporary and minor impacts to water quality, if any.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Salinity	Continued barrier and interior land losses results in conversion to open water habitats; increased number of tidal inlets, disruption of the tidal prism and increased salinity intrusion into Terrebonne Basin. The estuarine system would be converted to a more marine system thereby significantly reducing productivity. Vegetation species would be dominated by more salt tolerant species and existing salt-intolerant species would be displaced to fresher inland areas	The impacts of implementing Alternative 5 (NER Plan) would restore a net total of 2,781 acres on Raccoon, Whiskey, Trinity and Timbalier Islands restoring these barrier islands to their minimal geormorphological form and ecological functions. Implementing Alternative 5 (NER Plan) would maintain the important geomorphic boundary between the higher salinity waters from the GOM and the less saline Terrebonne estuarine system thereby preventing the conversion of the barrier system and the interior estuarine systems to open marine habitats and contribute to maintaining the estuarine salinity gradients.	The impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including restoring a net total of 527 acres of Whiskey Island to its minimal geormorphological form and ecological functions over the 50-year period of analysis thereby preventing the conversion of a portion of the Terrebonne barrier system and the interior estuarine systems to open marine habitats as well as contributing to maintaining the estuarine salinity gradients.	The impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan), including restoring a net total of 1,324 acres of Whiskey and Timbalier Islands to their minimal geormorphological forms and ecological functions over the 50-year period of analysis thereby preventing the conversion of a portion of the Terrebonne barrier system and the interior estuarine systems to open marine habitats as well as contributing to maintaining the estuarine salinity gradients.	The impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan), including restoring a net total of 1,851 acres of Whiskey and Timbalier Islands to their minimal geormorphological forms and ecological functions over the 50-year period of analysis thereby preventing the conversion of a portion of the Terrebonne barrier system and the interior estuarine systems to open marine habitats as well as contributing to maintaining the estuarine salinity gradients.	The indirect impacts of implementing Alternative 4 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan), including restoring a net total of 2,140 acres of Whiskey, Trinity and Timbalier Islands to their minimal geormorphological forms and ecological functions over the 50-year period of analysis thereby preventing the conversion of a portion of the Terrebonne barrier system and the interior estuarine systems to open marine habitats as well as contributing to maintaining the estuarine salinity gradients.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Air Quality	Without any action, air quality throughout the coastal Louisiana area, including the Study Area, would likely continue to decline due to continued human population growth throughout the general coastal area, further commercialization and industrialization (e.g., oil and gas operations), increased numbers of motor vehicles, and increased emissions from various engines.	Over the 50-year period of analysis Alternative 5 (NER) would restore a net total of 1,459 acres of vegetated barrier habitats that would help to improve local air quality by reducing particulates and gaseous air pollutants. Direct impacts to ambient air quality, resulting primarily from implementing Alternative 5 (NER Plan) would be primarily related to emissions of construction equipment within the Study Area. Impacts would be temporary and localized, with air quality returning to pre-construction conditions shortly after completion of construction activities.	The impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER) with restoration of a net total of 311 acres of vegetated barrier habitats that would help to improve local air quality by reducing particulates and gaseous air pollutants	The impacts of implementing Alternative 2 would be similar to those described for the Whiskey Island component of Alternative 5 (NER) with restoration of a net total of 706 acres of vegetated barrier habitats that would help to improve local air quality by reducing particulates and gaseous air pollutants.	The impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER) with restoration of a net total of 1,017 acres of vegetated barrier habitats that would help to improve local air quality by reducing particulates and gaseous air pollutants	The impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER) with restoration of a net total of 1,120 acres of vegetated barrier habitats that would help to improve local air quality by reducing particulates and gaseous air pollutants.
Noise	The No Action Alternative would have no direct impact on noise. Existing conditions would persist. Localized and temporary noise impacts, such as commercial and recreational fishing boats and oil and gas exploration activities, would likely continue to affect fish, wildlife and those humans that utilize the Study Area.	Construction activities associated with implementing Alternative 5 (NER Plan) would result in temporary and localized increases to noise levels in the Study Area. Any noise would be within OSHA standards.	Construction activities associated with implementing Alternative 11 would result in temporary and localized increases to noise levels in the Study Area. Any noise would be within OSHA standards.	Construction activities associated with implementing Alternative 2 would result in temporary and localized increases to noise levels in the Study Area. Any noise would be within OSHA standards.	Construction activities associated with implementing Alternative 3 would result in temporary and localized increases to noise levels in the Study Area. Any noise would be within OSHA standards.	Construction activities associated with implementing Alternative 4 would result in temporary and localized increases to noise levels in the Study Area. Any noise would be within OSHA standards.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Vegetation Resources	The No Action Alternative would result in the conversion of 3,220 acres of existing Terrebonne Basin barrier island beach, dune and marsh wetland vegetation habitats to open water bottom habitat over the 50-year period of analysis.	Alternative 5 (NER Plan) would initially restore a total of 5,840 acres on Raccoon, Whiskey, Trinity, and Timbalier Islands. This would include initial restoration of a total of 472 acres of dune, 4,320 acres of supratidal and 1,048 acres of intertidal vegetated habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements; increased vegetation growth and productivity; and reduced inter- and intra-specific species competition between resident and non-resident fish and wildlife species for limited coastal vegetation.	The direct impact to vegetation resources of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including initial restoration of a total 1,272 acres with 65 acres of dune, 830 acres of supratidal, 377 acres of intertidal vegetation resources on Whiskey Island	The direct impacts to vegetation resources of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan), including initial restoration of a total 2,630 acres with 215 acres of dune, 2,346 acres of supratidal, 69 acres of intertidal vegetation resources on Timbalier Island	The direct impacts to vegetation resources of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands component of Alternative 5 (NER Plan), including initial restoration of a total 3,902 acres with 280 acres of dune, 3,176 acres of supratidal, 446 acres of intertidal vegetation resources on Whiskey and Timbalier Islands.	The direct impacts to vegetation resources of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands component of Alternative 5 (NER Plan), including initial restoration of a total 5,051 acres with 409 acres of dune, 3,632 acres of supratidal, 1,010 acres of intertidal vegetation resources on Whiskey, Trinity and Timbalier Islands.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Wildlife and Habitat	The No Action Alternative would continue to degrade, fragment and eventually convert 3,220 acres of existing Terrebonne Basin barrier island beach, dune and intertidal wildlife habitats to marine-dominated open water bottom habitat over the 50-year period of analysis. The loss of existing barrier island and adjacent estuarine wildlife habitats would adversely impact important transitional habitat between estuarine and marine environments; essential fish habitat (EFH); unique wildlife habitat (e.g., nursery, nesting, feeding, and roosting habitats); and critical wintering habitat for the threatened piping plover.	The impacts of implementing Alternative 5 (NER) would be a net increase of 2,781 acres with 2,883 AAHUs of important and essential vegetated wildlife habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery and other life requirements; increased vegetation growth and productivity; and reduced inter- and intra-specific species competition between resident and non-resident fish and wildlife species for limited coastal vegetation.	The impacts of implementing Alternative 11 would be a net increase of 527 acres with 678 AAHUs of important and essential vegetated wildlife habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery and other life requirements; increased vegetation growth and productivity; and reduced inter- and intra-specific species competition between resident and non-resident fish and wildlife species for limited coastal vegetation.	The impacts of implementing Alternative 11 would be a net increase of 1,324 acres with 1,100 AAHUs of important and essential vegetated wildlife habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery and other life requirements; increased vegetation growth and productivity; and reduced inter- and intra-specific species competition between resident and non-resident fish and wildlife species for limited coastal vegetation.	The impacts of implementing Alternative 11 would be a net increase of 1,851acres with 1,778 AAHUs of important and essential vegetated wildlife habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery and other life requirements; increased vegetation growth and productivity; and reduced inter- and intra-specific species competition between resident and non-resident fish and wildlife species for limited coastal vegetation.	The impacts of implementing Alternative 11 would be a net increase of 2,140 acres with 2,406 AAHUs of important and essential vegetated wildlife habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery and other life requirements; increased vegetation growth and productivity; and reduced inter- and intra-specific species competition between resident and non-resident fish and wildlife species for limited coastal vegetation.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Benthic	Although conversion of 3,220 acres of existing barrier habitat and an unknown acreage of adjacent estuarine habitats to water bottoms would provide additional habitat for benthic organisms, the conversion would decrease available nutrients and detritus and result in the conversion of primarily estuarine-dependent benthic species assemblages to more marine-dominated and open water benthic species assemblages	Initial construction of Alternative 5 (NER Plan) would directly impact a total of 2,498 acres of borrow site water bottoms and benthic organisms utilizing these areas. Renourishment would directly impact a total of 1,222 acres. A total of 3,283 acres of existing water bottoms would be converted to beach, dune and marsh barrier habitats during initial construction. Renourishment would impact 1,633 acres of water bottoms and associated benthic organisms.	Initial construction of Alternative 11 would directly impact a total of 535 acres of borrow site water bottoms and benthic organisms utilizing these areas. Renourishment would directly impact a total of 859 acres. A total of 469 acres of existing water bottoms would be converted to beach, dune and marsh barrier habitats during initial construction. Renourishment would impact 823 acres of water bottoms and associated benthic organisms.	Initial construction of Alternative 2 would directly impact a total of 1,375 acres of borrow site water bottoms and benthic organisms utilizing these areas. Renourishment would directly impact a total of 26 acres. A total of 1,675 acres of existing water bottoms would be converted to beach, dune and marsh barrier habitats during initial construction. Renourishment would impact 202 acres of water bottoms and associated benthic organisms.	Initial construction of Alternative 3 would directly impact a total of 1,535 acres of borrow site water bottoms and benthic organisms utilizing these areas. Renourishment would directly impact a total of 885 acres. A total of 1,535 acres of existing water bottoms would be converted to beach, dune and marsh barrier habitats during initial construction. Renourishment would impact 1,025 acres of water bottoms and associated benthic organisms.	Initial construction of Alternative 4 would directly impact a total of 1,998 acres of borrow site water bottoms and benthic organisms utilizing these areas. Renourishment would directly impact a total of 1,108 acres. A total of 2,729 acres of existing water bottoms would be converted to beach, dune and marsh barrier habitats during initial construction. Renourishment would impact 1,562 acres of water bottoms and associated benthic organisms.
Plankton	Continued degradation and loss of barrier wetlands eventually result in decrease of available nutrients and detritus, which could lead to the conversion of primarily estuarine-dependent plankton species assemblages to more marine and open water plankton species assemblages.	The direct impacts to plankton resources of implementing Alternative 5 (NER Plan) would be localized and short-term adverse impacts, including mortality of some plankton populations, due to construction activities of terminal groin at Raccoon Island, dredging activities at borrow sites as well as placement of borrow for barrier island restoration.	The direct impacts to plankton resources of implementing Alternative 11 would be localized and short-term adverse impacts, including mortality of some plankton populations, due to construction activities of terminal groin at Raccoon Island, dredging activities at borrow sites as well as placement of borrow for barrier island restoration.	The direct impacts to plankton resources of implementing Alternative 2 would be localized and short-term adverse impacts, including mortality of some plankton populations, due to construction activities of terminal groin at Raccoon Island, dredging activities at borrow sites as well as placement of borrow for barrier island restoration.	The direct impacts to plankton resources of implementing Alternative 3 would be localized and short-term adverse impacts, including mortality of some plankton populations, due to construction activities of terminal groin at Raccoon Island, dredging activities at borrow sites as well as placement of borrow for barrier island restoration.	The direct impacts to plankton resources of implementing Alternative 4 would be localized and short-term adverse impacts, including mortality of some plankton populations, due to construction activities of terminal groin at Raccoon Island, dredging activities at borrow sites as well as placement of borrow for barrier island restoration.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Fisheries	Conversion of existing barrier island habitats to water bottom habitat would include degradation and loss of important essential fish habitats, especially transitional habitat between estuarine and marine environments, and would increase inter- and intra-specific competition between resident and migratory fish. As open water replaces barrier and estuarine wetland habitats and the extent of marsh-to-water interface begins to decrease, fishery productivity is likely to decline.	Impacts of implementing Alternative 5 (NER Plan) would be a net increase of 2,781 acres of transitional barrier habitats with 2,883 AAHUs of important and essential transactional habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements; increased vegetation growth and productivity; and reduced inter- and intra-specific species competition between resident and non-resident fish and wildlife species for limited coastal vegetation	Impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER) including a net increase of 527 acres of transitional barrier habitats with 678 AAHUs. In addition, Alternative 11 would restore Whiskey Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine wetlands to open water habitat thereby maintaining important transitional estuarine habitat for fisheries resources.	Impacts of implementing Alternative 11 would be similar to those described for the Timbalier Island component of Alternative 5 (NER) including a net increase of 1,324 acres of transitional barrier habitats with 678 AAHUs. In addition, Alternative 2 would restore Timbalier Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine wetlands to open water habitat thereby maintaining important transitional estuarine habitat for fisheries resources.	Impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER) including a net increase of 1,851 acres of transitional barrier habitats with 1,778 AAHUs. In addition, Alternative 3 would restore Whiskey and Timbalier Islands to their minimal geomorphologic form which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine wetlands to open water habitat thereby maintaining important transitional estuarine habitat for fisheries resources.	Indirect impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER) including a net increase of 2,140 acres of transitional barrier habitats with 2,406 AAHUs. In addition, Alternative 4 would restore Whiskey, Trinity and Timbalier Islands to their minimal geomorphologic form which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine wetlands to open water habitat thereby maintaining important transitional estuarine habitat for fisheries resources.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Essential Fish Habitat	Approximately 1,560 acres of existing intertidal back barrier marsh from the seven barrier island system, a more productive category of EFH, would be converted to marine-dominated water bottoms, a less productive EFH category. This loss would continue to adversely impact essential spawning, nursery, nesting, and foraging habitats for commercially and recreationally important species of finfish and shellfish, as well as other aquatic organisms.	Disruption of the Gulf of Mexico marine habitat EFH associated with borrow areas would temporarily displace the fishery that inhabitants the reefs and hard sand bottoms. Fishery organisms would likely use the borrow areas shortly after dredging activities cease. Benthic organisms would recolonize the borrow areas within one to two years. Impacts of implementing Alternative 5 (NER Plan) would be a net increase of 2,781 acres of transitional barrier habitats with 2,883 AAHUs of important and essential transitional habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements; increased vegetation growth and productivity; and reduced inter- and intra-specific species competition between resident and non-resident fish and wildlife species for limited coastal vegetation.	Impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER) including a net increase of 527 acres of transitional barrier habitats with 678 AAHUs.	Impacts of implementing Alternative 11 would be similar to those described for the Timbalier Island component of Alternative 5 (NER) including a net increase of 1,324 acres of transitional barrier habitats with 678 AAHUs.	Impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER) including a net increase of 1,851 acres of transitional barrier habitats with 1,778 AAHUs.	Indirect impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER) including a net increase of 2,140 acres of transitional barrier habitats with 2,406 AAHUs.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Threatened & Endangered Species	The No Action Alternative would result in the continued degradation and loss of designated critical wintering habitat and its primary constituents for the threatened piping plover. Other listed species could also be adversely impacted by the loss of the barrier islands including: Gulf sturgeon, green sea turtle, hawksbill sea turtle, Kemp's Ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, and the West Indian manatee.	Alternative 5 (NER Plan) would initially restore a total of 3,730 acres of piping plover critical wintering habitat over the four barrier islands. Impacts to piping plovers will be avoided by deterring the birds from nesting on the islands prior to constructions. Impacts to West Indian Manatees will be avoided by implementing a monitoring and avoidance plan during construction. Impacts to sea turtles will be avoided by utilizing a cutterhead dredge rather than a hopper dredge.	Impacts to listed species or their designate critical habitat would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including initial restoration of 624 acres of piping plover critical wintering habitat on Whiskey Island.	Impacts to listed species or their designate critical habitat would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including initial restoration of 2,053 acres of piping plover critical wintering habitat on Timbalier Island.	Impacts to listed species or their designate critical habitat would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including initial restoration of 624 acres of piping plover critical wintering habitat on Whiskey Island and 2,053 acres of piping plover critical wintering habitat on Timbalier Island.	Impacts to listed species or their designate critical habitat would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including initial restoration of 624 acres of piping plover critical wintering habitat on Whiskey Island, 2,053 acres of piping plover critical wintering habitat on Timbalier Island, and 434 acres of piping plover critical wintering habitat on Trinity Island.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Cultural & Historic Resources	As the barrier islands and interior marshes erode and/or subside, prehistoric cultural resources could become exposed to elements or inundated, putting them at a greater risk of damage or destruction.	A Phase I submerged cultural resources remote sensing investigation was conducted within the vicinity of Whiskey Island. Thirteen targets exhibiting potential cultural resources were identified. There will be no direct impacts to historic properties if the targets representing potential historic properties are avoided. No historic properties have been identified in the Raccoon, Timbalier or Trinity Island APE; therefore, no direct impacts to historic properties are anticipated. The South Pelto, Ship Shoal, Whiskey 3A , Raccoon Island, and New Cut Borrow Areas have been investigated, and targets representing potentially significant cultural resources will be avoided.	A Phase I submerged cultural resources remote sensing investigation was conducted within the vicinity of Whiskey Island. Thirteen targets exhibiting potential cultural resources were identified. There will be no direct impacts to historic properties if the targets representing potential historic properties are avoided. The Whiskey 3A and Ship Shoal Borrow Areas have been investigated, and targets representing potentially significant cultural resources will be avoided	No historic properties have been identified in the Timbalier Island APE; therefore, no direct impacts to historic properties are anticipated. The South Pelto, Whiskey 3A and Ship Shoal Borrow Areas have been investigated, and targets representing potentially significant cultural resources will be avoided.	The impacts of Alternative 3 will be equivalent to Alternatives 11 and 2. The South Pelto, Whiskey 3A, Raccoon, and Ship Shoal Borrow Areas have been investigated, and targets representing potentially significant cultural resources will be avoided.	A Phase I submerged cultural resources remote sensing investigation was conducted within the vicinity of Whiskey Island. Thirteen targets exhibiting potential cultural resources were identified. There will be no direct impacts to historic properties if the targets representing potential historic properties are avoided. No historic properties have been identified in the Timbalier or Trinity Island APE; therefore, no direct impacts to historic properties are anticipated. The South Pelto, Whiskey Island , Raccoon Island, and New Cut Borrow Areas have been investigated, and targets representing potentially significant cultural resources will be avoided

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Aesthetics	Without implementation of the barrier restoration features, existing conditions will persist resulting in the continued loss and degradation of the barrier islands. Degradation of the barrier islands would convert existing views of beach, dune, and wetland to more open water views.	Impacts to visual resources would primarily result from newly created high quality emergent wetland viewscapes that would provide a long-term visual enhancement of an area that is presently experiencing a decline in visual complexity. There may be some perceived visual disturbance as an unnatural terminal groin structure is placed at the end of Raccoon Island.	Impacts similar to Alternative 5 (NER Plan) except that no terminal groin would be constructed.	Impacts similar to Alternative 5 (NER Plan) except that no terminal groin would be constructed.	Impacts similar to Alternative 5 (NER Plan) except that no terminal groin would be constructed.	Impacts similar to Alternative 5 (NER Plan) except that no terminal groin would be constructed.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Recreation	As existing barrier islands are lost and freshwater wetland/marsh areas transition to saltwater marsh, and subsequently to open water, the recreational opportunities would change accordingly. As populations of freshwater and/or saltwater species decline, so would fishing opportunities. In transitional and upland areas where populations of game species exist, hunting opportunities would be reduced as the landscape became less supportive of those species. The same holds true for the populations of migratory waterfowl and other bird species, which will affect opportunities for viewing	Impacts of implementing Alternative 5 (NER Plan) would be a net increase of 2,781 acres of transitional estuarine wetlands. Following construction, these transitional estuarine wetlands will provide important and essential fish and wildlife habitats that will contribute to restoring and nurturing the food chain for the organisms that provide the base for recreational activities such as fishing, wildlife viewing, and camping. Increased opportunity for recreational activities will come from expansion of new vegetative habitat on newly created areas and the protection from storm-related stressors that the restored beach, dune, and marsh areas will afford adjacent existing habitats.	Impacts to recreational resources would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including a net increase of 527 acres of transitional estuarine wetlands.	Impacts to recreational resources would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including a net increase of 1,324 acres of transitional estuarine wetlands.	Impacts to recreational resources would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including a net increase of 1,851 acres of transitional estuarine wetlands.	Impacts to recreational resources would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including a net increase of 2,140 acres of transitional estuarine wetlands.
Population and Housing	Study area is remote and uninhabited.	Study area is remote and uninhabited.	Study area is remote and uninhabited.	Study area is remote and uninhabited.	Study area is remote and uninhabited.	Study area is remote and uninhabited.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Employment and Income	Study area is remote and uninhabited, employment and income primarily related to oil and gas and commercial fisheries and which may locally decrease due to barrier habitat degradation and loss.	Alternative 5 (NER) will protect, create and nourish essential fish and wildlife habitats that will contribute to restoring and nurturing the food chain for the organisms that provide the base for commercial and recreational activities such as fishing and ecotourism. Restored and protected wetlands could obviate the need for abandonment or relocation of otherwise vulnerable oil and gas facilities, and the employment opportunities that accompany them.	Implementing this single island alternative would provide limited benefits to commercial and recreational fisheries by increasing the quantity and quality of essential fish habitat available for nursery and other aquatic life functions. In addition this alternative provides some protection of adjacent oyster leases from being directly exposed to the higher saline waters of the Gulf	Impacts similar to Alternative 11.	Impacts similar to Alternative 5 (NER Plan).	Impacts similar to Alternative 5 (NER Plan).
Community Cohesion	The No Action Alternative may have cumulative impacts on community cohesion if the islands continue to erode to the point where the interior wetlands cease to protect the upland communities.	By slowing wetland loss and retaining the protective function of the barrier islands communities dependent on the basin resources would be less likely to lose cohesion and community identity.	Impacts similar to Alternative 5 (NER Plan), but to a much lesser extent.	Impacts similar to Alternative 5 (NER Plan), but to a much lesser extent.	Impacts similar to Alternative 5 (NER Plan), but to a lesser extent.	Impacts would be similar to Alternative 5 (NER), but of reduced scope, since it only involves three islands
Environmental Justice	There would be no impact of the No Action Alternative on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.	There would be no direct impact of Alternative 5 (NER) on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.	There would be no direct impact of Alternative 11 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.	There would be no direct impact of Alternative 2 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.	There would be no direct impact of Alternative 3 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.	There would be no direct impact of Alternative 4 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Infrastructure	The existing private infrastructure includes oil and gas pipelines; storage tank batteries, platforms, and wellheads. The effects of continued barrier island loss and degradation will lead to increased costs for maintenance and repair of the existing infrastructure, reduced level of oil and gas infrastructure development, and possible relocation of some existing oil and gas assets.	Implementing the NER Plan would provide protection to the private infrastructure on and adjacent to the four islands. Due to the planned renourishment events, this protection should last for the duration of the 50-year period of analysis. Appropriate safety precautions will be implemented for this and all other alternatives to avoid potential construction-related impacts to existing infrastructure.	Implementing Alternative 11 would provide protection to the existing infrastructure in the immediate area of Whiskey Island for the 50-year period of analysis, due to the proposed renourishment events are undertaken in TY20 and TY40. Appropriate safety precautions will be implemented for this and all other alternatives to avoid potential construction-related impacts to existing infrastructure.	Implementing Alternative 2 would provide protection to the extensive existing infrastructure in the immediate area of Timbalier Island for the 50-year period of, due to the renourishment event is undertaken in TY30. Appropriate safety precautions will be implemented for this and all other alternatives to avoid potential construction-related impacts to existing infrastructure.	Impacts would be a combination of Alternatives 11 and 2.	The impacts would be similar to Alternative 5 (NER), but to a somewhat lesser extent benefit because Alternative 4 only involves three islands.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Business and Industry	The primary industry in the Study Area involves oil and gas extraction, processing, and transmission. The effects of continued barrier island loss and degradation will lead to increased maintenance costs for existing oil and gas infrastructure, reduced level of oil and gas infrastructure development, and relocation of some existing oil and gas assets. Impact to the commercial fishery businesses will result from the gradual decline in abundance of the target resources which will require adjustment to other target species or relocation to other more productive fishing grounds.	The NER Plan will provide protection to the industrial infrastructure on and adjacent to the four islands. In addition the restored marshes will continue to provide the shelter and nursery functions required by the estuary-dependent fishery resources.	Whiskey Island does not protect any industrial infrastructure, so the direct impact of its restoration will be negligible. However, restoration of the marsh and its protective beach and dune will provide a benefit to the fishery resources similar to Alternative 5 (NER), but at a reduced scale.	The impacts of implementing Alternative 2 would be similar to Alternative 11. In addition, Timbalier Island protects a significant amount of industrial infrastructure from direct impact from the Gulf of Mexico and, similarly to Whiskey Island, the restored marsh and its protective beach and dune will provide a benefit to fishery resources.	The impacts of implementing Alternative 3 would be similar to Alternative 5 (NER) but to a lesser extent because Alternative 3 only involves two islands. However, Timbalier Island has extensive industrial infrastructure that would be protected.	The impacts of implementing Alternative 4 would be similar to Alternative 5 (NER) but to a somewhat lesser extent because Alternative 3 only involves three islands. However, Timbalier Island has extensive industrial infrastructure that would be protected.
Traffic and Transportation	The Study Area consists of a series of remote, uninhabited barrier islands, accessible only by shoal-draft boat or aircraft. There is no public or private transportation infrastructure. There would be no direct impacts of the No Action on traffic and transportation, as this feature does not exist within the Study Area.	There is no public or private transportation infrastructure in the Study Area.	There is no public or private transportation infrastructure in the Study Area.	There is no public or private transportation infrastructure in the Study Area.	There is no public or private transportation infrastructure in the Study Area.	There is no public or private transportation infrastructure in the Study Area.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Public Facilities & Services	There are no public facilities or public services on the islands. Three of the islands, Raccoon, Whiskey, and Wine Islands, are managed as a wildlife refuge by the Louisiana Department of Wildlife and Fisheries, however trespass is prohibited.	There are no public facilities or public services on the islands.	There are no public facilities or public services on the islands.	There are no public facilities or public services on the islands.	There are no public facilities or public services on the islands.	There are no public facilities or public services on the islands.
Local Government Finance	There are no local government expenditures for public services on the islands.	There are no local government expenditures for public services on the islands.	There are no local government expenditures for public services on the islands.	There are no local government expenditures for public services on the islands.	There are no local government expenditures for public services on the islands.	There are no local government expenditures for public services on the islands.
Tax Revenue & Property Values	The islands are predominately owned by the State; No taxes are assessed on these properties. There are a few parcels of private landowners on Trinity, Timbalier, and East Timbalier. However, the taxable values and associated revenues are minimal.	Tax revenues and property values would not significantly change by the construction of Alternative 5 (NER Plan).	Tax revenues and property values would not significantly change by the construction of Alternative 11.	Tax revenues and property values would not significantly change by the construction of Alternative 2,	Tax revenues and property values would not significantly change by the construction of Alternative 3.	Tax revenues and property values would not significantly change by the construction of Alternative 4.
Community and Regional Growth	There would be no direct, impacts of the No Action Alternative on community and regional growth, as these features do not exist within the Study Area.	There would be no direct, impacts of Alternative 5 (NER Plan) on community and regional growth, as these features do not exist within the Study Area.	There would be no direct, impacts of Alternative 11 on community and regional growth, as these features do not exist within the Study Area.	There would be no direct, impacts of Alternative 2 on community and regional growth, as these features do not exist within the Study Area.	There would be no direct, impacts of Alternative 3 on community and regional growth, as these features do not exist within the Study Area.	There would be no direct, impacts of Alternative 4 on community and regional growth, as these features do not exist within the Study Area.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Agriculture	There would be no direct impacts of the No Action Alternative on agriculture or silviculture land use, as these uses do not exist within the Study Area.	There would be no direct impacts of the Alternative 5 (NER Plan) on agriculture or silviculture land use, as these uses do not exist within the Study Area.	There would be no direct impacts of the Alternative 11 on agriculture or silviculture land use, as these uses do not exist within the Study Area.	There would be no direct impacts of the Alternative 2 on agriculture or silviculture land use, as these uses do not exist within the Study Area.	There would be no direct impacts of the Alternative 3 on agriculture or silviculture land use, as these uses do not exist within the Study Area.	There would be no direct impacts of the Alternative 4 on agriculture or silviculture land use, as these uses do not exist within the Study Area.
Forestry	There would be no direct impacts of the No Action Alternative on forestry land use, as these uses do not exist within the Study Area.	There would be no direct impacts of the Alternative 5 (NER Plan) on forestry land use, as these uses do not exist within the Study Area.	There would be no direct impacts of the Alternative 11 on forestry land use, as these uses do not exist within the Study Area.	There would be no direct impacts of the Alternative 2 on forestry land use, as these uses do not exist within the Study Area.	There would be no direct impacts of the Alternative 3 on forestry land use, as these uses do not exist within the Study Area.	There would be no direct impacts of the Alternative 4 on forestry land use, as these uses do not exist within the Study Area.
Public Lands	Since the islands are predominately owned by the State, the continued degradation and eventual disappearance of the islands will reduce the amount of public lands in the Study Area.	The impacts of implementing Alternative 5 (NER) would be a net increase of 2,781 acres with 2,883 AAHUs of important and essential vegetated wildlife habitats on public lands.	The impacts of implementing Alternative 11 would be a net increase of 527 acres with 678 AAHUs of important and essential vegetated wildlife habitats used by fish and wildlife habitats on public lands.	The impacts of implementing Alternative 11 would be a net increase of 1,324 acres with 1,100 AAHUs of important and essential vegetated wildlife habitats used by fish and wildlife habitats on public lands.	The impacts of implementing Alternative 11 would be a net increase of 1,851acres with 1,778 AAHUs of important and essential vegetated wildlife habitats on public lands.	The impacts of implementing Alternative 11 would be a net increase of 2,140 acres with 2,406 AAHUs of important and essential vegetated wildlife habitats on public lands.
Water Use and Supply	There are no water supply facilities within the Study Area.	There are no water supply facilities within the Study Area.	There are no water supply facilities within the Study Area.	There are no water supply facilities within the Study Area.	There are no water supply facilities within the Study Area.	There are no water supply facilities within the Study Area.
Navigation	The continued wetland loss may affect navigability and maintenance of both the federally- and privately-maintained waterways, including the Houma Navigation Canal and several smaller bayous.	The impacts of implementing the Alternative 5 (NER Plan) would be temporary disruption of recreational and commercial vessel traffic in the vicinity of each island and borrow area during construction.	The impacts of implementing the Alternative 11 would be temporary disruption of recreational and commercial vessel traffic in the vicinity of each island and borrow area during construction.	The impacts of implementing the Alternative 2 would be temporary disruption of recreational and commercial vessel traffic in the vicinity of each island and borrow area during construction.	The impacts of implementing the Alternative 3 would be temporary disruption of recreational and commercial vessel traffic in the vicinity of each island and borrow area during construction.	The impacts of implementing the Alternative 4 would be temporary disruption of recreational and commercial vessel traffic in the vicinity of each island and borrow area during construction.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Oil, Gas, Utilities, Pipelines	The No Action Plan would result in the persistence of existing conditions including the fragmentation and degradation of the existing barrier islands and inland marshes. The unimpeded erosion of these areas will continue to uncover pipelines that have been buried both on the islands and on the seafloor. As these pipelines are exposed, they will become susceptible weathering, boat collisions, and impacts from anchor dragging.	The construction of the Alternative 5 (NER Plan) will benefit the pipelines on the four islands by further covering them with fill material. This will provide a protective barrier from weather-related impacts as well as impacts associated with the day-to-day operation of the oil and gas facilities. Impacts to pipelines in the borrow areas are highly unlikely a buffer zone will be applied to each pipeline to provide additional protection during construction.	There are no oil and gas pipelines or infrastructure located within the proposed template for Alternative 11 (Whiskey Island). Therefore, placement of fill on the island will not have any direct impacts on oil and gas activities Impacts to pipelines in the borrow areas are highly unlikely a buffer zone will be applied to each pipeline to provide additional protection during construction.	Construction of Alternative 2 will directly benefit the two active pipelines that are on Timbalier Island by further covering them will fill material. This will provide a protective barrier from weather-related impacts as well as impacts associated with the day-to-day operation of the oil and gas facilities Impacts to pipelines in the borrow areas are highly unlikely a buffer zone will be applied to each pipeline to provide additional protection during construction.	There is no oil and gas infrastructure on Whiskey Island. Construction of Timbalier Plan E, however, will directly benefit the two active pipelines that are on the island by further covering them will fill material and providing a protective barrier. Impacts to pipelines in the borrow areas are highly unlikely a buffer zone will be applied to each pipeline to provide additional protection during construction.	There is no oil and gas infrastructure on Whiskey or Trinity Island. Construction of Timbalier Plan E, however, will directly benefit the two active pipelines that are on the island by further covering them will fill material and providing a protective barrier. Impacts to pipelines in the borrow areas are highly unlikely a buffer zone will be applied to each pipeline to provide additional protection during construction.
Flood Control and Hurricane Protection	There are no flood control structures within or nearby the Study Area.	There are no flood control structures within or nearby the Study Area. However, construction of Alternative 5 (NER Plan) will help to protect the mainland from storm surge and wave impacts.	There are no flood control structures within or nearby the Study Area. However, construction of Alternative 11 will help to protect the mainland from storm surge and wave impacts.	There are no flood control structures within or nearby the Study Area. However, construction of Alternative 2 will help to protect the mainland from storm surge and wave impacts.	There are no flood control structures within or nearby the Study Area. However, construction of Alternative 3 will help to protect the mainland from storm surge and wave impacts.	There are no flood control structures within or nearby the Study Area. However, construction of Alternative 4 will help to protect the mainland from storm surge and wave impacts.

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Commercial Fisheries	The continued wetland habitat losses within the Study Area, combined with widespread coastal wetland loss throughout coastal Louisiana, would contribute to the overall decrease in productivity of Louisiana's coastal fisheries.	Impacts of implementing Alternative 5 (NER Plan) would be a net increase of 2,781 acres of transitional barrier habitats with 2,883 AAHUs of important and essential habitats used by fish for shelter, nesting, feeding, and other life requirements. The indirect impact from implementing the NER would be a temporary disruption of commercial fishing vessel traffic in the vicinity of the dredge over the borrow area during construction.	Impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER) including a net increase of 527 acres of transitional barrier habitats with 678 AAHUs of important and essential habitats used by fish for shelter, nesting, feeding, and other life requirements.	Impacts of implementing Alternative 11 would be similar to those described for the Timbalier Island component of Alternative 5 (NER) including a net increase of 1,324 acres of transitional barrier habitats with 678 AAHUs of important and essential habitats used by fish for shelter, nesting, feeding, and other life requirements.	Impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER) including a net increase of 1,851 acres of transitional barrier habitats with 678 AAHUs of important and essential habitats used by fish for shelter, nesting, feeding, and other life requirements.	Indirect impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER) including a net increase of 2,140 acres of transitional barrier habitats with 2,406 AAHUs transitional barrier habitats with 678 AAHUs of important and essential habitats used by fish for shelter, nesting, feeding, and other life requirements.
Oyster Leases	The ongoing loss of wetlands in the Study Area would alter the detritus-based food web of the oyster thereby reducing the localized carrying capacity of the oyster leases in the area.	The immediate direct impacts of Alternative 5 (NER Plan) would include disturbance to water bottoms from the placement of dredged material. Once construction is completed the direct impact of implementing the NER Plan would be stabilization of the barrier islands, thus providing additional sheltered habitat for oyster settlement, and creation of additional marsh habitat, leading to increased production of detritus and catabolic compounds.	Impacts would be similar to Alternative 5 (NER Plan), but to a much lesser extent since only one island is being restored (Whiskey).	Impacts would be similar to Alternative 5 (NER Plan), but to a much lesser extent since only one island is being restored (Timbalier).	Impacts would be similar to Alternative 5 (NER Plan), but to a lesser extent since only two islands are being restored (Whiskey and Timbalier).	Impacts would be similar to Alternative 5 (NER Plan), but to a lesser extent since three islands are being restored (Whiskey, Trinity, and Timbalier).

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
HTRW	Based on current and historical uses of the Study Area for oil and gas exploration and development, there is reason to believe that the potential to encounter HTRW problems would be moderate. Furthermore, increased susceptibility of oil and gas infrastructure to coastal processes could increase the potential for HTRW within the Study Area	Impacts similar to the No Action Alternative	Impacts similar to the No Action Alternative	Impacts similar to the No Action Alternative	Impacts similar to the No Action Alternative	Impacts similar to the No Action Alternative
D. Contributions to Planning Objectives[b]						
Provide an expanded footprint of minimized barrier island section to provide the geomorphic form and ecologic function of the Terrebonne Basin barrier island, reducing volume loss within the LCA TBBSR Study Area below the historic average (1880 through 2005).	0	2	2	2	2	2
Restore and improve various barrier island habitats that provide essential habitats for fish, migratory birds, and other terrestrial and aquatic species, mimicking, as closely as possible, conditions which would occur naturally in the area for the 50 year period of analysis.	0	2	2	2	2	2

	No-Action Alternative	Alternative 5 (NER Plan)	Alternative 11	Alternative 2	Alternative 3	Alternative 4
Increase sediment input to supplement longshore sediment transport processes along the gulf shoreline by mechanically introducing compatible sediment, and increasing the ability of the restored area to continue to function and provide habitat for the 50 year period of analysis with minimum continuing intervention.	0	2	2	2	2	2
E. Planning Constraints[b]						
Lack of suitable sediments for restoration	0	2	2	2	2	2
Environmental impacts of human activities in the Study Area	0	2	2	2	2	2
Infrastructure and cultural resources that must be avoided or relocated	0	2	2	2	2	2
Limitations in the characterization and simulation of environmental processes	0	2	2	2	2	2
F. Response to Evaluation Criteria[b]						
Completeness	0	2	2	2	2	2
Effectiveness	0	2	2	2	2	2
Efficiency	0	2	2	2	2	2
Acceptability	0	2	2	2	2	2

a. When determining fully funding project costs, the preliminary costs were refined using MCACES. These cost refinements were only performed on the NER Plan and first component of construction.
b. 0 = Does not meet; 1 = Partial meets; 2 = Meets

3.9 Risk and Uncertainty

3.9.1 Simulation Uncertainties

Risks and uncertainties related to the formulation, selection and implementation of the Study plan have been considered in this study. Uncertainties in the analysis of the alternatives are associated with the precision of the information on coastal erosion process and the methods used to assess performance of alternatives. Physical processes associated with the evolution of coastal landforms are generally very complex. While the underlying principles controlling these processes are well understood, reliable simulation of such processes and their interactions (wind and wave processes, ocean currents, tides, sediment transport, storms) may require very large amounts of data. In order to analyze the alternatives at an appropriate level of detail and reliability for selection of the preferred plan, a number of simplifying assumptions and approaches were used to evaluate the restoration feature performance for the alternatives. These uncertainties, assumptions and limitations on reliability of the analyses are provided in the Engineering Appendix. Where uncertainties are present regarding the particular values to use for certain processes or conditions in the study, generally, a mid-range value was selected. A value assignment may be selected that is not at or near the mid point of a range of estimates where the value can be justified based on the best professional judgment of the PDT members, or where there is a particular rationale for the value selected, such as the need for a conservative safety factor in selection of an estimate.

3.9.2 Weather-related Risks

Risks associated with the Study alternatives are primarily related to the possibility of extreme weather events during the Study period of performance. If a powerful tropical weather system passes over the Study Area early in the Study life, the overall performance and benefits of the restoration features may be greatly reduced, or even eliminated, by such an event. Smaller scale storm events have been incorporated into estimates of coastal processes, such as shoreline retreat, for evaluation of the alternatives. The assumptions are based on near-term and long-term historical observations of the frequency of repeat events that are considered likely to occur during the Study life. While a project could be designed to provide benefits after impacts of a major storm event, this approach would require costs and resource commitments that would be unnecessary under conditions that are more likely to occur during the period of evaluation.

3.9.3 Relative Sea-Level Rise Uncertainties

According to EC-1165-2-211, relative sea-level rise (RSLR) must be considered in every USACE coastal activity. In order to determine the range of possible future rates of sea-level rise, the PDT followed an 18-step guidance document developed by the USACE (USACE, 2009). The guidance document provides a methodology for determining a low (historic), intermediate, and high RSLR rate for a particular Study Area. The intermediate and high rates represent possible future acceleration of sea-level rise. A flowchart of the steps is provided in Appendix L.

The low RSLR rate was determined using historical data collected at Grand Isle, LA (http://tidesandcurrents.noaa.gov). Analysis of the data revealed a mean sea level (MSL) trend of 9.24 mm/year, which is equivalent to a change of 0.030 ft/year. This estimated MSL trend combines the global MSL rise and a subsidence rate of 0.24 ft/yr. Subsidence was calculated by subtracting the local MSL rise rate from the regional MSL rate. The future sea-level change values for the low rate were then determined by extrapolating the historic linear trend into the future.

The eustatic sea-level rise rates for the intermediate and high rates were determined using the modified NRC Curves I and III, respectively. RSLR rates were then calculated by summing the eustatic rates and the subsidence rate of 0.24 ft/yr. Table 3-46 presents low/historic, intermediate and high relative sea-level changes for TY0, TY5, TY10, TY25, and TY50.

Table 3-46. Estimated relative sea-level rise rates

Rate Type	Period	Eustatic SLR (ft)	Subsidence (ft)	Relative SLR (ft)
Low/Historic	2006-2012 (TY0)	0.033	0.144	0.177
	2006-2017 (TY5)	0.061	0.264	0.325
	2006-2022 (TY10)	0.089	0.384	0.473
	2006-2037 (TY25)	0.173	0.744	0.917
	2006-2062 (TY50)	0.312	1.344	1.656
Intermediate (NRC Curve I)	2006-2012 (TY0)	0.055	0.144	0.199
	2006-2017 (TY5)	0.105	0.264	0.369
	2006-2022 (TY10)	0.159	0.384	0.543
	2006-2037 (TY25)	0.343	0.744	1.087
	2006-2062 (TY50)	0.729	1.344	2.073
High (NRC Curve III)	2006-2012 (TY0)	0.124	0.144	0.268
	2006-2017 (TY5)	0.246	0.264	0.510

Rate Type	Period	Eustatic SLR (ft)	Subsidence (ft)	Relative SLR (ft)
	2006-2022 (TY10)	0.385	0.384	0.769
	2006-2037 (TY25)	0.899	0.744	1.643
	2006-2062 (TY50)	2.085	1.344	3.429

During plan formulation, the PDT agreed that the intermediate RSLR rate would be the most appropriate rate to utilize in the initial development, evaluation, and screening of the Study alternatives. Consequently, habitat acres, AAHUs, and erosion rates discussed in the preceding sections of the report are based on this rate. However, to meet the requirements of EC 1165-2-211, the PDT concurrently conducted an evaluation of the alternatives utilizing the high and low RSLR rates. Each of the plans in the Intermediate Array was subjected to low and high RSLR rates to determine a new set of habitat acres for each target year. Table 3-47 presents a comparison of the average annual habitat acres for the low, intermediate, and high RSLR rates for the island plans in the NER Plan prior to the addition of renourishment.

Table 3-47. Comparison of average annual habitat acres for low, intermediate, and high SLR rates

Rate Type	Average Annual Habitat Acres				
	Whiskey Plan C	Trinity Plan C	Raccoon Plan E w/TG	Timbalier Plan E	Total
Low/Historic	968	788	723	2034	4513
Intermediate (NRC Curve I)	944	777	722	2029	4472
High (NRC Curve III)	754	634	676	1922	3986

Should the RSLR coincide with the low rates as calculated per EC 1165-2-211, output will be slightly greater than anticipated. However, should the RSLR equal the high sea level rise trend, the Study will produce approximately 11% less acres than anticipated.

As stated above, the EC 1165-2-211 assumes constant subsidence rate. A comparative analysis of the historic erosion rates adopted for the study and relative SLR-induced erosion rates expressed in terms of the Bruun Rule presented in Appendix L, demonstrates that the uncertainties associated with future subsidence rate are more than accounted for.

3.9.4 Cost Estimate Uncertainties

In compliance with Engineer Regulation (ER) 1110-2-1302 Civil Works Cost Engineering, dated September 15, 2008, formal risk analyses studies were conducted for the development of contingency on the total project cost for the initial restorations of the NER Plan and first component of construction exclusive of the operation and maintenance construction activities. The purpose of these risk analyses studies were to establish project contingencies by identifying and measuring the cost and schedule impact of project uncertainties with respect to the estimated project cost for the initial restoration of the NER Plan and first component of construction.

A risk analysis begins with the identification of risk factors for the Study. The risks are then compared for commonalities with other risk factors and a preliminary risk register is developed for risk level assignment. Following risk level evaluation and assignment, those risk factor found to have 'moderate' or 'high' impact risks are carried forward to the final risk register and quantified. The final risk register serves as the risk models used within the Crystal Ball software.

The fully funded construction costs calculated for the 80% confidence level of contingency as per USACE Civil Works guidance are shown in Tables 3-48 through 3-50 for the NER Plan and first component of construction, respectively. The fully funded construction cost contingencies for the 50% and 100% confidence levels are also provided for illustrative purposes. Tables 3-51 and 3-52 present the fully funded project costs of the initial restoration components for the NER Plan and first component of construction, respectively based on the anticipated contracts. These costs are intended to address the congressional request of project cost estimates to implement the Study.

Table 3-48. NER Plan Initial Restoration - Cost Estimate with Contingencies Summary (Contract No. 1 – Whiskey, Trinity, & Raccoon Islands)

Contingency Level	MII Cost Estimate ($1,000)	Contingency Percentage from Risk Analysis	Total Contingency & Escalation ($1,000) [1]	Fully Funded Cost ($1,000) [2]
50% Confidence Level - Initial Restoration Project Cost	$260,000	17.9%	$47,000	$307,000
80% Confidence Level - Initial Restoration Project Cost	$260,000	27.4%	$71,000	$331,000
100% Confidence Level - Initial Restoration Project Cost	$260,000	60.3%	$157,000	$417,000

[1] Adaptive management plan cost includes prior escalation & contingency and is subjected to the total contingency and escalation.
[2] Costs taken from risk analysis forecasts

Table 3-49. NER Plan Initial Restoration - Cost Estimate with Contingencies Summary (Contract No. 2 - Timbalier Island)

Contingency Level	MII Cost Estimate ($1,000)	Contingency Percentage from Risk Analysis	Total Contingency & Escalation ($1,000) [1]	Fully Funded Cost ($1,000) [2]
50% Confidence Level - Initial Restoration Project Cost	$245,000	19.3%	$47,000	$292,000
80% Confidence Level - Initial Restoration Project Cost	$245,000	29.4%	$72,000	$317,000
100% Confidence Level - Initial Restoration Project Cost	$245,000	66.0%	$162,000	$407,000

[1] Adaptive management plan cost includes prior escalation & contingency and is subjected to the total contingency and escalation.
[2] Costs taken from risk analysis forecast

Table 3-50. Initial Restoration - Cost Estimate for the First Component of Construction with Contingencies Summary

Contingency Level	MII Cost Estimate ($1,000)	Contingency Percentage from Risk Analysis	Total Contingency & Escalation ($1,000) [1]	Fully Funded Cost ($1,000) [2]
50% Confidence Level - Initial Restoration Project Cost	$90,100	18.4%	$16,600	$107,000
80% Confidence Level - Initial Restoration Project Cost	$90,100	27.7%	$24,990	$115,000
100% Confidence Level - Initial Restoration Project Cost	$90,100	59.2%	$53,320	$143,000

[1] Adaptive management plan cost includes prior escalation & contingency and is subjected to the total contingency and escalation.
[2] Costs taken from risk analysis forecast

Table 3-51. Fully Funded Cost Summary for NER Plan Initial Restoration

Project Element	Program Year Cost	Total Contingencies & Escalations [1]	Fully Funded Total [2]
Lands & Damages	$545,000	$169,000	$715,000
Fish & Wildlife (Adaptive Management Plan)	$5,820,000	Included	$5,820,000
Breakwaters & Seawalls	$1,830,000	$661,000	$2,490,000
Beach Replenishment	$463,000,000	$156,000,000	$619,000,000
PED	$23,000,000	$6,850,000	$30,000,000
Construction Management	$23,000,000	$7,800,000	$31,000,000
NER Initial Restoration Fully Funded Costs	$518,000,000	$171,000,000	$689,000,000

[1] Adaptive Management Plan cost includes prior escalation & contingency and is subjected to the Total Contingency and Escalation.
[2] Costs taken from TPCS

Table 3-52. Fully Funded Cost Summary for Initial Restoration of the First Component of Construction

Project Element	Program Year Cost	Total Contingencies & Escalations [1]	Fully Funded Total [2]
Lands & Damages	$51,000	$16,000	$67,000
Fish & Wildlife (Adaptive Management Plan)	$5,820,000	Included	$5,820,000
Beach Replenishment	$78,000,000	$25,000,000	$103,000,000
PED	$3,920,000	$1,120,000	$5,040,000
Construction Management	$3,920,000	$1,240,000	$5,160,000
Initial Restoration Fully Funded Costs	$92,000,000	$27,000,000	$119,000,000

[1] Adaptive Management Plan cost includes prior escalation & contingency and is subjected to the Total Contingency and Escalation.
[2] Costs taken from TPCS

Additional information on the Risk Analyses are presented in Appendix L.

3.9.5 Recommendations for Future Research

The PDT identified the following research/data collection opportunities that will improve future barrier island projects:

- Pre-and post-storm survey data to enable SBEACH model verification;
- Updated topographic and bathymetric surveys;
- Analysis of past barrier island restoration projects
- Analysis of physical process of the barrier island system as a whole (sediment transport model, geomorphic profile models)
- Island specific and system-wide sediment budget
- Quantitative ecological benefits of barrier island restoration on inland habitats
- Additional modeling to refine our predictive capabilities of the effectiveness of detached breakwaters, terminal groins and other hard structures

3.10 Implementation Requirements

3.10.1 Schedule

3.10.1.1 Milestones

Table 3-53 presents an anticipated schedule of major milestones for implentation of the NER Plan.

Table 3-53. Anticipated Schedule of Milestones

Milestones	Schedule
Final Report	August 2010
Division Engineer Notice	August 2010
Washington Level Review	August 2010
Execute Cost-Sharing Agreement for PED	September 2010
State and Agency Review	October 2010
Chief of Engineers Report	December 2010
Begin Preconstruction Engineering and Design	2010
ASA and OMB Review	2011
ASA Report to Congress	2011
Complete Design Documentation Report	2011
Complete Plans and Specifications	2011
Execute PPA	2011
Complete Real Estate Acquisition	2011
Advertise Construction	2012
Construction Start	2012
Complete Construction	2016
Turnover Project to Local Sponsor	2016
Initiate Monitoring and Adaptive Management	During PED

Complete Monitoring and Adaptive Management	2026

3.10.1.2 Design Schedule

The design schedule follows the elements of the PED outlined in Engineering Regulation ER1110-2-1150 (USACE, 1999) which include: study reformulation; documentation of design; technical review conference; design documentation reports; permit applications; value engineering; hazardous, toxic, and radioactive waste assessments; relocations; physical model studies; preparation of the project cooperation agreement; preparation of plans and specifications; independent government estimates; review of NEPA document; and independent technical review.

On a project following the full normal authorization process, the PED phase begins when the Major Subordinate Command Commander issues the public notice for the feasibility report and PED funds are allocated to the district. PED generally requires a period of up to two years, depending on the complexity of the project, and ends with completion of the plans and specifications for the first construction contract or as otherwise defined in the PED cost-sharing agreement. Engineering functions shall be prepared to begin an intensive effort immediately upon notification that PED funds are available.

For the LCA TBBSR Study, it is estimated this phase will last approximately 15 months. Time should be saved because the alternatives analysis, fill template designs, and borrow area identification were completed as part of the engineering feasibility study. Surveys, volume calculations, and cost estimate will have to be updated at the design level prior to completing final plans and specifications.

3.10.1.3 Construction Schedule

The construction schedule for the initial restoration of the NER Plan and first component of construction consists of project mobilization/demobilization and construction access, beach/dune and marsh fill placement, and borrow area pipeline relocation for both the NER Plan and the first component of construction. The NER Plan was divided into two separate construction contracts. The NER Plan Contract No.1 consists of the initial restoration of Whiskey Island, Trinity Island, and Raccoon Island with terminal groin. The NER Plan Contract No. 2 consists of initial restoration of Timbalier Island. The islands were divided between the contracts on the basis of common borrow area allocations and construction duration. Construction of NER Plan Contracts No.1 and No. 2 shall begin concurrently. The estimated timeline for construction of the NER Plan and first component of construction are summarized below and described in detail in Appendix L.

The following assumptions were made in developing the construction schedules:

- Single dredge plant would be utilized per contract
- NER Plan Contracts No.1 and No.2 would commence construction simultaneously
- Construction Access for each subsequent island would be constructed concurrent with the previous island's fill placement
- March Fill containment dikes would be constructed concurrent with beach/dune fill placement
- Construction of the Terminal Groin would be done concurrent with fill placement.

3.10.1.3.1 NER Plan Restoration Construction Schedule Contract No. 1

- Project Mobilization: 56 days
- Whiskey Island Beach/Dune Construction: 325 days
- Borrow Area Pipeline Relocation: 94 days
- Trinity Island Beach/Dune Construction: 168 days
- Borrow Area Pipeline Relocation: 63 days
- Trinity Island Marsh Construction: 193 days
- Borrow Area Pipeline Relocation: 60 days
- Whiskey Island Marsh Construction: 23 days
- Borrow Area Pipeline Relocation: 61 days
- Raccoon Island Beach/Dune: 204 days
- Raccoon Island Marsh & Terminal Groin Construction: 109 days
- Borrow Area Pipeline Relocation: 56 days
- Raccoon Island Marsh Construction: 48 days
- Demobilization: 35 days

Total construction time for initial restoration of the NER Plan Contract No. 1 is 49.2 months.

3.10.1.3.2 NER Plan Restoration Construction Schedule Contract No. 2

- Project Mobilization: 71 days
- Timbalier Island Beach/Dune Construction: 474 days
- Timbalier Island Marsh Construction: 130 days
- Borrow Area Pipeline Relocation: 112 days
- Timbalier Island Marsh Construction: 237 days

- Borrow Area Pipeline Relocation: 81 days
- Timbalier Island Marsh Construction: 61 days
- Demobilization: 52 days

Total construction time for initial restoration of the NER Plan Contract No. 2 is 40.1 months. Contract No. 2 will run concurrently with Contract No. 1.

3.10.1.3.3 Initial Restoration Construction Schedule for the First Component of Construction

- Project Mobilization: 56 days
- Whiskey Island Beach/Dune Construction: 325 days
- Borrow Area Pipeline Relocation: 65 days
- Whiskey Island Marsh Construction: 23 days
- Demobilization: 37 days

Total construction time for the initial restoration of the first component of construction is 16.6 months. Vegetative plantings and sand fencing will be scheduled following fill activities in accordance with Appendix L.

3.10.2 Implementation Responsibilities

The non-Federal sponsor shall, prior to implementation, agree to perform all of the local cooperation requirements and non-Federal obligations. Local cooperation requirements and non-Federal sponsor obligations include, but are not necessarily limited to:

- Provide a minimum of 35 percent of total project costs as further specified below:
    - Enter into an agreement which provides, prior to execution of the project partnership agreement, 25 percent of design costs;
    - Provide, during the first year of construction, any additional funds needed to cover the non-Federal share of design costs;
    - Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material that the Government determines to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project;
    - Provide, during construction, any additional funds necessary to make its total contribution equal to 35 percent of the total project costs allocated to the project;

- Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project;
- Not use funds provided by a Federal agency under any other Federal program, to satisfy, in whole or in part, the non-Federal share of the cost of the project unless the Federal agency that provides the funds determines that the funds are authorized to be used to carry out the study or project;
- Not use project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project;
- For as long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the project, or functional portions of the project, including mitigation, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and state laws and regulations and any specific directions prescribed by the Federal Government;
- Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspecting, operating, maintaining, repairing, replacing, rehabilitating, or completing the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall relieve the non-Federal sponsor of responsibility to meet the non-Federal sponsor's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance;
- Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors;
- Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the initial construction, periodic nourishment, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

- Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the initial construction, periodic nourishment, operation, or maintenance of the project;
- Agree that, as between the Federal Government and the non-Federal sponsor, the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, and repair the project in a manner that would not cause liability to arise under CERCLA;
- Prevent obstructions of or encroachments on the project (including prescribing and enforcing regulations to prevent such obstruction or encroachments) which might reduce ecosystem restoration benefits, hinder operation and maintenance, or interfere with the project's proper function, such as any new developments on project lands or the addition of facilities which would degrade the benefits of the project;
- Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as would properly reflect total costs of construction of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;
- Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5), and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;
- Comply with all applicable Federal and state laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army," and all applicable Federal labor standards and requirements, including but not limited to 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying, and enacting without substantial change the provisions of the Davis-Bacon Act

(formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c et seq.); and

- Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for the initial construction, periodic nourishment, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

3.10.3 Cost Sharing

The State of Louisiana, acting through the Coastal Protection and Restoration Authority of Louisiana (CPRA), will be the non-Federal sponsor for the LCA TBBSR Study. In November 2008, the USACE and CPRA executed a single Feasibility Cost-Share Agreement covering six Louisiana Coastal Area near-term plan elements listed in Section 7006(e) of the Water Resources Development Act of 2007. The six features each underwent a separate feasibility analysis and environmental compliance analysis culminating in a single master feasibility document. The cost-share during the feasibility phase was 50% Federal and 50% non-Federal. However, the individual elements have been divided so that each entity had lead responsibility for preparing three of the six report components. At the end of the feasibility phase the total cost for all elements will have been shared on a 50/50 basis, yet for work on each individual element during the feasibility phase the ratio of funds expended by either the Federal or non-Federal sponsor will be higher depending upon their level of responsibility. CPRA had the technical planning lead for this particular LCA study element.

Following the feasibility phase, the cost share for the planning, design and construction of the project will be 65% Federal and 35% non-Federal. CPRA must provide all LERRDs required for the project. The 35% share of the project cost includes the CPRA's responsibility for providing all LERRDs. Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) of the project would be a 100% CPRA responsibility. The cost apportionment of the NER Plan and first component of construction is presented in Tables 3-54 and 3-55.

Under current law, authority for the non-Federal sponsor to receive credit for construction activities is limited. Section 7007(a) of WRDA 2007 authorizes the Secretary to credit, "toward the non-Federal share of the cost of a study or project under this title the cost of work carried out in the coastal Louisiana ecosystem by the non-Federal interest for the project before the date of the execution of the partnership agreement for the study or project." In addition, section 7007(a) incorporates the requirement of section 221 of the Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) that the Government and non-Federal sponsor must enter into a separate agreement for any work that will be carried out prior to execution of the partnership agreement. In other words, work undertaken by the non-Federal sponsor prior to (but not after) execution of the project partnership agreement (PPA) is eligible for credit subject to execution of a separate agreement covering such work before it is undertaken. For design work that the non-Federal sponsor proposes to undertake, the Design Agreement will serve as the required separate agreement. For construction work that the non-Federal sponsor proposes to undertake, an In-Kind Memorandum of Understanding will be required. Opportunities to enter into an In-Kind MOU for construction activities will depend on the schedule for entering into the PPA for a project.

Section 7007(d) provides that credit afforded under section 7007 that is in "excess" of the non-Federal cost share for a study or project authorized in Title VII of the Water Resources Development Act of 2007 may be applied toward the non-Federal cost share of any other study or project under that title. "Excess" credit will be applied only toward another study or project involving the same sponsor. In addition, "excess" credit will be applied within project phases (i.e., study to study, design to design, and construction to construction). At this time, it is anticipated that that there are limited opportunities for the application of "excess credit" from other Title VII projects toward these projects.

Table 3-54. Cost apportionment for the NER Plan – Initial Restoration

Item	Total	Federal	Non-Federal
PED	$29,000,000	$19,000,000	$10,000,000
Construction Management	$29,000,000	$19,000,000	$10,000,000
Adaptive Management	$5,820,000	$3,780,000	$2,040,000
Construction	$582,000,000	$379,000,000	$203,000,000
LERRD	$692,000	$0	$692,000
Total (First Costs)	$647,000,000	$421,000,000	$226,000,000

Table 3-55 Cost apportionment for the First Component of Construction – Initial Restoration

Item	Total	Federal	Non-Federal
PED	$4,890,000	$3,180,000	$1,710,000
Construction Management	$4,890,000	$3,180,000	$1,710,000
Adaptive Management	$5,820,000	$3,780,000	$2.040,000
Construction	$98,000,000	$64,000,000	$34,000,000
LERRD	$65,000	$0	$65,000
Total (First Costs)	$4,890,000	$3,180,000	$1,710,000

3.10.4 Environmental Commitments

The USACE, its non-Federal sponsor (CPRA) and contractors commit to avoiding, minimizing, or mitigating for adverse effects during construction activities by taking the following actions:

1. Employ best management practices with regard to erosion and turbidity control. Prior to construction, the construction team should examine all areas of proposed erosion/turbidity control in the field, and make adjustments to the plan specified in the plan control device as warranted by actual field conditions at the time of construction.

2. The contract specifications will prohibit the contractor from dumping oil, fuel, or hazardous wastes in the work area and will require that the contractor adopt safe and sanitary measures for the disposal of solid wastes. The contractor will be required to prepare a spill prevention plan.

3. Demolition debris would be transported to a landfill or otherwise disposed of in accordance with Federal, State, and local requirements. Concrete or paving materials would be disposed of in accordance with Federal, State, and local requirements.

4. Inform contractor personnel of the potential presence of threatened and endangered species in the Study area, the need for precautionary measures and the Endangered Species Act prohibition on taking listed species.

5. Special measures will be incorporated during project construction to minimize effects to any listed species that may be present. These measures are presented in the Biological Assessment (Appendix A).

6. Both the CPRA and the USFWS have been consulted for recommendations on avoidance of impacts to federally listed and State listed species. Both the CPRA and USFWS will be consulted in the event that colonial or solitary wading bird nests are observed within the construction footprint.

7. The USACE agrees to maintain an open and cooperative informal consultation process with the USFWS throughout the design, construction, and operation of this restoration project.

8. To protect cultural resources, stipulations resulting from Section 106 consultation with the ACHP, SHPO, and Federally recognized Indian tribes will be followed. Language will be included in construction contract specifications outlining the steps to be taken in the event of the discovery of a previously unidentified historic property, including archaeological sites, human remains, and properties of traditional religious and cultural significance to Indian tribes during the execution of the project. An informational training session, developed by a professional archaeologist, will be conducted for the contractor's personnel to explain what kinds of archaeological/cultural materials might be encountered during construction of the island plan, and the steps to be taken in the event these materials are encountered. A professional archaeologist will conduct periodic monitoring of the Study area during ground disturbing activities to determine if activities are impacting unanticipated historic properties.

During the review process for the Integrated Feasibility Report and Final EIS a number of issues were raised that will be addressed during the PED process. These issues fell naturally into six groups or themes:

- Consider project design, construction phasing, project operations planning, and adaptive management scenarios that minimize impacts to the organisms and their habitats. Concerns are Threatened and Endangered (T&E) species, marsh hydroperiod stability, and the need for robust modeling to support project operations and maintenance and aggressive adaptive management (necessity for rapid response to changing conditions);
- Consider expansion of geotechnical, geophysical, and cultural resources data gathering and analysis to further refine borrow areas for beach/dune and marsh fill, and to locate additional cost effective fill sources;
- Consider expansion of geotechnical data gathering and analysis relevant to excavation and stability of native soils/water bottoms for access channel and containment dike construction and post-construction degradation;

- Ensure ongoing consultation and cooperation with local, State, and Federal resource and environmental agencies to address protection and enhancement of habitat stability, heterogeneity, and longevity, as well as life-cycle protection for fish and wildlife, especially T&E species such as shore birds, at both the borrow areas and the fill-placement areas;
- Due to the highly variable nature of the coastal processes within the Terrebonne Basin and the limitations of modeling barrier island restoration performance and response to structures with the GENESIS model, conduct combined wave and current modeling on a system-wide level to support the National Ecosystem Restoration Plan; and
- The feasibility level monitoring and adaptive management plan will be revised to include consideration for expanding the monitoring plan to better assess physical processes that govern the geomorphologic changes of the islands. However, this detailed level of monitoring may be considered more of a research activity than monitoring specifically aimed at determining if a Study has achieved its objectives. Further, a more detailed description of the scope and cost-sharing for the monitoring and adaptive management plan will be provided.

3.10.5 Financial Requirements

It is expected that the CPRA will have the capacity to provide the required local cooperation for the first component of construction. A project schedule and cost estimate will be provided to the CPRA so that it may develop a financing plan. A standard cost share percentage of 65% Federal and 35% non-Federal would be applied to the total first cost of the project, including the value of PED costs construction features.

Section 7007(b) of WRDA 2007 provides that "The non-Federal interest may use, and the Secretary shall accept, funds provided by a Federal agency under any other Federal program, to satisfy, in whole or part, the non-Federal share of the cost of the study or project if the Federal agency that provides the funds determines that the funds are authorized to carry out the study or project." If the Mineral Management Services determines in writing that funds it provides to the non-Federal sponsor under the Energy Policy Act of 2005 (Coastal Impact Assistance Program - CIAP) and the Gulf of Mexico Energy Security Act of 2006 (GOMESA) are authorized to be used to carry out LCA projects, the non-Federal sponsor can use those funds toward satisfying its local cooperation for the project, including the non-Federal sponsor's acquisition of Lands, Easements, Relocations, Right-of-ways and Disposals (LERRDs) required for the project.

By letters dated July 2, 2009 and December 18, 2009, the Minerals Management Service and the USACE established a process for the Minerals Management Service to provide its written determination regarding the acceptability of the use of CIAP funds for LCA studies, projects, and programs. That process provides that the Minerals Management Services' written determination for a specific study, project, or program will take the form of the grant award document for that activity.

3.10.6 Views of Non-Federal Sponsor

CPRA TBBSR Study and sponsoring the project construction in accordance with the items of local cooperation that are set forth in the recommendations chapter of this report. In addition, CPRA supports the NER Plan (Alternative 5) since this plan restores the geomorphologic form and ecologic function of the four islands in the Terrebonne Basin barrier system by creating a total of 4,792 acres of beach/dune and 1,048 acres of marsh. The plan is also cost-effective and provides the most benefits of all the Best-Buy plans in the final array. However, due to authorized cost limitations in WRDA 2007, CPRA supports Whiskey Island Plan C as the first component of construction. CPRA believes the project warrants additional Congressional authorization to increase funding and allow the implementation of the NER Plan (Alternative 5) to fully address the barrier island needs identified in this report.

The State of Louisiana fully supports the project. The State recognizes that the USACE's position is that section 7007 does not authorize credit for work carried out after the date of a partnership agreement. However, the state disagrees with the USACE position and intends to continue to seek a change in law that would allow in-kind contribution credit for work carried out after the date of a Project Partnership Agreement and that would allow for such in-kind contributions credit to carry over between LCA Program components (i.e., “excess” credit for work undertaken after signing of the project partnership agreement for one project may be carried over for credit to another project). Nevertheless, while the State is of the opinion that its view is consistent with the authority and Congressional intent under WRDA 2007, the state fully intends to proceed with the project under the Corp’s interpretation of current law and to meet all non-Federal financial and other obligations outlined by the USACE in this report until such time as the law is changed.

The following is a final letter of intent that was submitted to Colonel Edward R. Fleming on behalf of CPRA:

CPRA
Coastal Protection and
Restoration Authority of Louisiana

Colonel Edward R. Fleming
New Orleans District
U.S. Army Corps of Engineers
P.O. Box 60267
New Orleans, LA 70160-0267

August 9. 2010

Dear Col. Fleming:

The State of Louisiana is pleased to offer its continuing support of the Louisiana Coastal Area (LCA) Multi-purpose Operation of the Houma Canal Lock, Terrebonne Basin Barrier Shoreline Restoration, Small Diversion at Convent/Blind River, Amite River Diversion Canal Modification, Medium Diversion at White's Ditch, and Convey Atchafalaya River Water to Northern Terrebonne Marshes projects as authorized in the Water Resources Development Act of 2007 (WRDA 2007). These projects are a critical part of the overall LCA Program and a vital component in rehabilitating the natural system of coastal Louisiana that serves to protect the economic and energy security of both the state and nation, the safety of more than 2 million Louisiana residents, the ecological balance of the Gulf region, and the survival of a unique culture.

This letter, while not legally binding on the State as an obligation of future funds appropriated by the State Legislature, declares our full support for the LCA Multi-purpose Operation of the Houma Canal Lock, Terrebonne Basin Barrier Shoreline Restoration, Small Diversion at Convent/Blind River, Amite River Diversion Canal Modification, Medium Diversion at White's Ditch, and Convey Atchafalaya River Water to Northern Terrebonne Marshes projects as described in the draft reports dated August 2010, with cost sharing as required in WRDA 2007. Accordingly, the State acknowledges that the projects require the non-Federal sponsor to contribute 35% of the total project costs, including all lands, easements, rights-of-way, relocations, and any improvements on lands, easements, and rights-of-way required for disposal of dredged material. The State also acknowledges that it will be required to perform all activities necessary to operate, maintain, rehabilitate, repair and replace the projects at the State's expense, including the performance of renourishment for the Terrebonne Basin Barrier Shoreline Restoration Project features as described in the feasibility report for that project. The State of Louisiana fully supports these projects, and the Coastal Protection and Restoration Authority will make diligent efforts to secure all necessary funding, including asking the State legislature for additional appropriations if necessary. Nevertheless, the Coastal Protection and Restoration Authority and the State of Louisiana reserve the right to seek the enactment of Federal law to reduce the non-Federal cost share.

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The State of Louisiana and the Coastal Protection and Restoration Authority whole-heartedly endorse this and other Corps' efforts to restore Louisiana's coastal ecosystem, and we look forward to working with the Corps on the implantation of these important projects.

Respectfully,

Garret Graves
Chair
Coastal Protection and Restoration Authority

4.0 AFFECTED ENVIRONMENT

This chapter describes the climate, geomorphic and physiographic setting, and the historic and existing conditions for the following significant resources: soils; coastal vegetation; wildlife; fisheries; plankton; benthos; essential fish habitat (EFH); threatened and endangered species; coastal processes and hydrology; salinity regimes; water quality; recreation; cultural resources; aesthetics; air quality; socioeconomic and human resources (including population; infrastructure; employment and income; navigation; oil, gas, and utilities; pipelines; commercial fisheries; oyster leases; and flood control and hurricane protection). In addition, the characterization of noise and hazardous, toxic, and radioactive waste (HTRW) in the Study Area are presented.

A resource is considered important if it is recognized by statutory authorities including laws, regulations, Executive Orders (EO), policies, rules, or guidance; if it is recognized as important by some segment of the general public; or if it is determined to be important based on technical or scientific criteria. The following sections discuss historic and existing conditions of each important resource occurring within the Study Area. The final programmatic environmental impact statement (EIS) for the Louisiana Coastal Area (LCA) Ecosystem Restoration Study (USACE 2004) presents detailed information relevant to this current study. Consistent with 40 CFR Part 1502.21, that information is incorporated by reference.

The Terrebonne Basin, similar to the rest of coastal Louisiana, including its wetlands, lakes, bays, and barrier shorelines, was produced by the deltaic processes of the Mississippi River in the east and Gulf and Riverine processes in the west. The Terrebonne Basin contains an extraordinary diversity of coastal habitats that range from natural levees and beach ridges to forested swamps, freshwater, intermediate, brackish and saline marshes, freshwater lakes, and bays of variable salinity. These landforms, along with their related hydrologic and biological processes, provide unique habitats that are crucial to the viability of migratory birds, commercial and recreational fisheries, and a great variety of terrestrial and aquatic species. Coastal wetlands also contribute to water quality in the region by reducing suspended sediment and nutrient loading in the aquatic environment. In human terms, these coastal wetlands have been a center for culturally diverse social development recognized and appreciated worldwide. In addition, coastal landforms and wetlands reduce the impact of flooding and storm surges on infrastructure in the coastal region, including highways, oil and gas production facilities, pipelines, and navigation features, such as ports and channels (USACE, 2008).

4.1 ENVIRONMENTAL SETTING OF STUDY AREA

4.1.1 Location

The Study, located in LCA Subprovince 3, provides for the restoration of the Timbalier and Isles Dernieres Barrier Island reaches located in Terrebonne and Lafourche Parishes, Louisiana. The Study Area (Figure 1-1) is located in the 3rd Congressional District. The Study Area consists of the barrier islands being considered for restoration as well as Ship Shoal.

Isles Dernieres Reach

The Isles Dernieres Reach represents a barrier island arc approximately 22 miles long in the southern reaches of Terrebonne Parish and extends from Caillou Bay east to Cat Island Pass. Raccoon, Whiskey, Trinity, East, and Wine, the primary islands that comprise the Isles Dernieres barrier island reach, are backed by Bay Blanc, Bay Round, Caillou Bay and Terrebonne Bay, and bordered by the Gulf of Mexico (GOM) on the seaward side. The remnant of Wine Island is located in Wine Island Pass, about midway between East and Timbalier Islands. The islands of the Isles Dernieres Reach range from approximately 0.1 to 0.85 miles wide and are typically composed of a thin sand cap over a thick mud platform. Elevations are generally low and the islands are frequently overwashed (USACE, 2004c).

For more than a century, the Isles Dernieres have experienced significant and persistent degradation and fragmentation. The average long-term (1887–2002) rate of shoreline change for the Isles Dernieres was -34.7 ft/yr with a range of -56.0/-17.0 ft/yr. The average short-term (1988–2002) rate of shoreline change was -61.9 ft/yr with a range of -60.5/-38.6 ft/yr (USACE, 2004c).

For more than 150 years, the Isles Dernieres has been an important commercial and recreational resource for Louisiana and the nation. The primary commercial activities in the area, oil and gas mineral extraction and fisheries harvesting, are interwoven inshore and offshore of the islands. As well, the islands have historically played an important role in coastal Louisiana recreation. The Isles Dernieres contained the first major coastal resort in Louisiana (later washed away by the great hurricane of 1856), and continues to provide premier hunting and fishing recreation for both State residents and non-residents alike (USACE, 2004c).

Timbalier Reach

The Timbalier Reach is comprised of Timbalier Island and East Timbalier Island. Timbalier and East Timbalier Islands are on the western edge of the Lafourche barrier shoreline and are located about 60 miles southwest of New Orleans, Louisiana. This barrier island shoreline is approximately 20 miles long and backed by Terrebonne and Timbalier Bay to the north and delimited by Raccoon Pass to the east and Cat Island Pass to the west. The islands range from 0.1 to 0.6 miles wide, with low elevations. Though onshore and offshore oil and gas development and production facilities are supported by both Timbalier and East Timbalier Islands, those facilities are prevalent on and around the East Timbalier but are few and scattered along Timbalier Island. Oil and gas canals are present on both islands (USACE, 2004c).

<u>Ship Shoal</u>

Ship Shoal is the largest and easternmost of a series of sand shoals on the inner continental shelf of Louisiana and contains approximately 1.6 billion cy of fine sand (Stone et al. 2009). The elongated shoal lies parallel to the coast approximately 8 to 12 miles (12 to 19 km) south of the Isles Dernieres Reach and measures approximately 31 miles (50 km) in an east-west direction (Khalil et al. 2007). The potential borrow areas identified within the shoal include Ship Shoal MMS Lease Blocks 87, 88, 89, 94, and 95 South Pelto Blocks 12, 13, 14, 18, and 19.

4.1.2 Climate

Climate is one of the major factors necessitating implementation of the proposed action. The climate of coastal Louisiana is one that is significantly influenced by the Gulf of Mexico (GOM) water and wind systems. These maritime conditions give rise to a humid subtropical climate, with long, hot, humid summers, and mild, abbreviated winters (USACE, 2004b). Summers are hot and humid, with temperatures averaging approximately 81.0°F. Winters are typically mild, with average temperatures of approximately 52.0°F, however short periods of colder temperatures may be induced by dry continental arctic air. The daily averages for coastal Louisiana are 78.4°F, and 58.8°F for the maximum and minimum temperatures respectively. The climate in the Study Area provides an extended frost-free period (264 day per year average), resulting in an average growing season of 317 days per year (USDA, 2005).

The maritime tropical air masses typically move inland and mix with continental air masses, producing abundant rainfall, impeding winter air masses, and reducing extreme inland temperatures. Wind records indicate that, annually, average wind speed in coastal Louisiana is approximately 9.8 ft per second from the southeast (USACE, 2004b). Localized rain events, which consist of severe summer storms, and sporadic, high-energy winter disturbances, are typically controlled by these offshore unstable air masses and winds. The average rainfall in the coastal zone of Louisiana is approximately 54 inches a year. Though rain events occur frequently (approximately 74 days each year), and are fairly well distributed throughout the year, storm frequencies are slightly elevated during the summer (July typically contains the highest storm frequency), and are typically least severe, and least frequent in October (USDC, 1998). Compounding the effects of severe wind and rain events, are the low topography that is common along the coastal marsh and barrier islands.

Louisiana is susceptible to tropical waves, tropical depressions, tropical storms, and hurricanes due to its proximity to the Gulf of Mexico. Historical data from 1899 to 2007 indicate that 30 hurricanes and 41 tropical storms have made landfall along the Louisiana coastline (National Weather Service, http://www.srh.noaa.gov/lch/research/tropical5.php and National Hurricane Center, http://www.nhc.noaa.gov). The total amount of marsh lost as a result of Hurricanes Katrina and Rita was over one third of the total predicted wetland losses that was predicted by the Coast 2050 Report (LCWCRTF and WCRA, 1999).

Preliminary information on land area changes that occurred shortly after Hurricanes Katrina and Rita, serve as a regional baseline for monitoring wetland recovery following the 2005 hurricane season. Estimation of permanent losses cannot be made until several growing seasons have passed and the transitory impacts of the hurricanes are minimized, but this preliminary analysis indicates an approximate 217-mi^2 (562.03-km^2) decrease in land/increase in water across coastal Louisiana. (Barras, John A. 2006).

The Gulf Coast region is affected by tropical and extra-tropical storms. Tropical storm events can directly and indirectly contribute to coastal land loss through a variety of ways: 1) erosion from increased wave energies; 2) removal and/or scouring of vegetation from storm surges; and 3) saltwater intrusion into interior wetlands carried by storm surges. These destructive processes can result in the loss and degradation of large areas of coastal habitats in a relatively short period of time (days and weeks versus years). Since 1893, over 130 tropical storms and hurricanes have struck or indirectly impacted Louisiana's coastline. On average, a tropical storm or hurricane affects Louisiana every 1.2 years. During the past 100 years, over 50 hurricanes and tropical storms have made landfall along the Louisiana coast with the highest incidence occurring in September.

The National Data Buoy Center, part of the National Oceanic and Atmospheric Administration (NOAA), provides a climatic summary (Table 4-1) from December 1984 to November 2001 for station GDIL1 at Grand Isle, Louisiana, which is east of the Terrebonne Basin. Climate in the Study Area is semitropical, primarily influenced by the Gulf of Mexico and largely determined by 2 pressure ridges. Though the fair weather conditions between the Study Area and Louisiana coastal zone are comparable, the direct and indirect impacts that unique climate conditions have on the barrier islands and coastal marshes are more detrimental.

Table 4-1 Climate statistics

	Minimum	Mean	Maximum
Air Temperature	14.2°F	70.3 °F	93.7 °F
Sea Temperature	28.6 °F	72.9 °F	95.0 °F
Air Pressure	29.1 in	30.0 in	30.8 in
Wind Speed	0.0 mph	11.2 mph	61.1 mph
Wind Direction, Summer	NA	44% SE	NA
Wind Direction, Winter	NA	38% N	NA
Rainfall	NA	65 in	NA

Source: http://seaboard.ndbc.noaa.gov/data/climatic/GDIL1.pdf

4.1.3 Geomorphic and Physiographic Setting

The geomorphic and physiographic setting is institutionally significant because of the National Environmental Policy Act (NEPA) of 1969. Geomorphic and physiographic conditions are technically significant because they can place constraints on the nature, design, or location of the proposed action, as well as determine the impacts, which the proposed action will have on other resources. Geomorphic and physiographic conditions are publicly significant because bedrock may be too hard for excavation or too weak to support proposed structures; mineral deposits may be destroyed or occluded by development of the proposed action; the existence of active faults or other hazardous geomorphic structures may compromise the proposed action.

The following geomorphic and physiographic setting information is incorporated by reference from the LCA FPEIS (per NEPA Section 1502.21; USACE, 2004b).

The Study Area is comprised of a chain of barrier islands and headlands, separated by tidal inlets, which enclose shallow bays. The most prominent physiographic features are the numerous narrow beaches and their associated dunes, overwash fans, spits, tidal inlets, marshes, and bays. Elevations range from a maximum of approximately 5 ft NAVD 88 on the highest dunes to near 0 ft NAVD 88 in the back barrier marshes. All of the island segments are retreating. Erosion, reworking, and redistribution of the coarser deltaic material led to the development of the barrier island chain present today. Much of the erosion and transport of material takes place during storms (frontal passages and tropical storms/hurricanes).

Geologic History:

Since the Late Jurassic geologic time, a sedimentary succession in excess of 6 miles thick, deposited in fluvial, deltaic, and marine environments, has accumulated. The northern margin of the Gulf basin continues to be the site of major deltaic deposition. Today, the basin receives approximately 6.1 million tons of sediment annually from North America's largest drainage basin of more than 1.2 million square miles (mi^2). The trunk distributary of this drainage system is the Mississippi River. During the Holocene, the river constructed the Mississippi River Deltaic Plain, one of the world's largest delta plains in excess of 11,500 mi^2. The Deltaic Plain consists of a generally fine-grained sedimentary package deposited within a wide variety of fluvial, deltaic, and coastal depositional environments (USACE, 2004c).

Deltaic Cycle:

The geologic development of coastal Louisiana and the resulting coastal landscape were dependent upon shifting Mississippi River courses and are influenced by the orderly progression of events related to the "deltaic cycle." The deltaic cycle is a dynamic and episodic process alternating between periods of "delta-building" with seaward advancement (progradation) of deltas and the subsequent landward retreat (degradation). As deltas are abandoned, the seaward edges are reworked into barrier headlands and barrier islands. Subsequently, the wetland complex behind the headlands and islands, without a significant and continuous source of sediment and nutrients, eventually succumbs to subsidence and becomes submerged by marine waters. The Mississippi River has changed its course several times during the last 7,000 years. Each time the Mississippi River has built a major delta it has eventually abandoned that river course in favor of a shorter, more direct route to the GOM.

The Deltaic Plain is composed of six major delta complexes: two prograding and four degrading (Figure 4-1). The Atchafalaya and Modern Delta complexes are active and the Teche, Lafourche, and St. Bernard complexes are inactive. Present day Terrebonne Basin is the result of the Lafourche delta formation, through seaward advancement from deposition of Mississippi River distributary sediment, the subsequent delta degradation and detachment, and the reworking of seaward headlands to form barrier islands (USACE, 2004a).

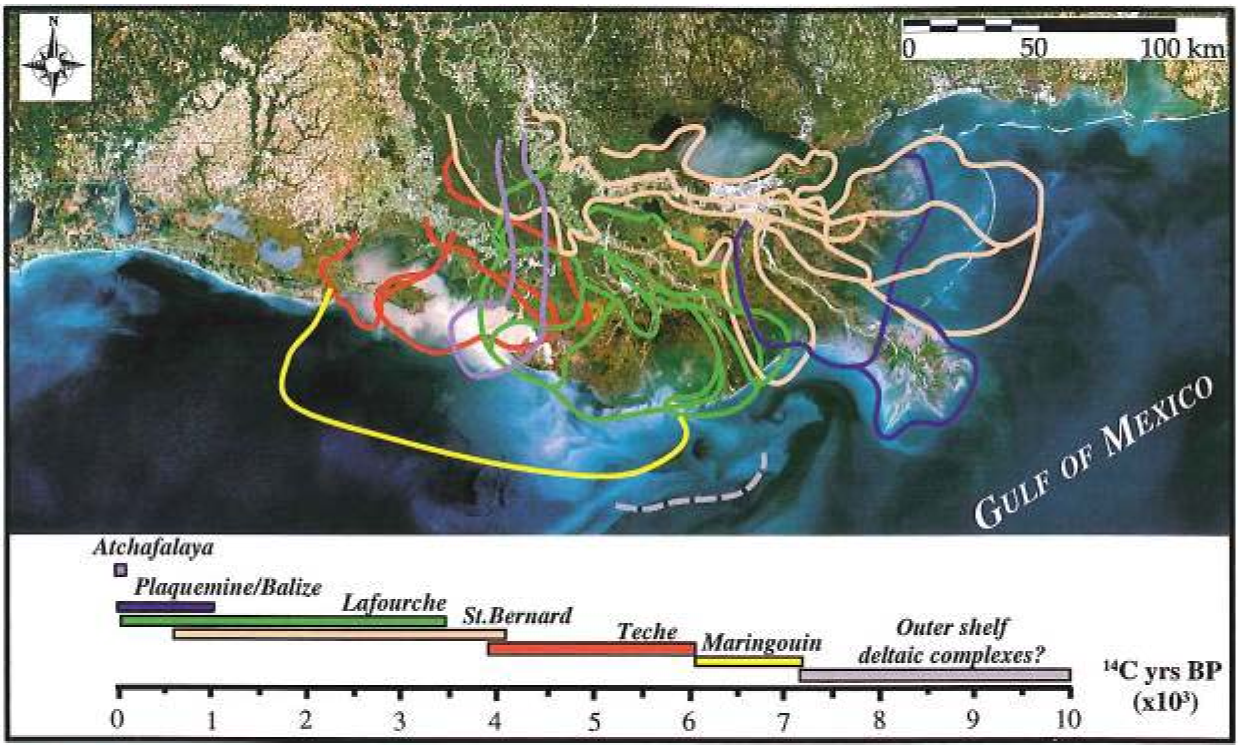

Figure 4-1. Mississippi River deltaic plain (Kulp et al., 2005)

Delta Advancement:

The Mississippi River Deltaic Plain wetland ecosystem developed as a result of delta-building processes, during which sea-level conditions were relatively stable. The deltaic cycle is initiated when the Mississippi River, enters an open water body, such as a coastal lake or bay, which slows the velocity of the River's flow, thus limiting the River's ability to transport sediment. Consequently, most of the larger-grained sediment carried by the River drops out of the water column and falls to the bottom. Over time, the River deposits enough sediment to create land, which then becomes colonized by wetland plants. The organic deposition from additional River-borne sediment and decomposing wetland vegetation are the primary factors behind the land-building process. In this fashion, large expanses of wetlands, or deltas, form and extend seaward between the distributaries, or "fingers" of the delta, as long as the River continues to supply freshwater, nutrients, and land-building sediment (USACE, 2004a).

Delta Abandonment:

As a delta grows and extends into the GOM, the River stage gradually heightens. Eventually, the River breaks through a weak point in its bank and/or shifts its main water flow into a distributary, thus providing a shorter route for the River to travel to the Gulf. About every 1,000 years, the Mississippi River had altered its path to the Gulf, sometimes flowing down the western portion of the current Deltaic Plain and sometimes down the eastern portion. Whenever the River changed course, the location of active delta building also changed. Areas that no longer received sufficient volumes of freshwater laden with sediment and nutrients began to succumb to subsidence, while those areas that received the majority of River water input began a new phase of delta building. These meandering changes in the course of the Mississippi River and accompanying shifts in centers of sediment deposition are responsible for the distribution of deltaic sediment along the entire Louisiana coast and into Texas.

Once the Mississippi River had altered its course and began to form a new delta, tidal influences and a lack of sediment and nutrient inputs had slowly degraded the previously active delta location. Over time, the interior wetlands were submerged and marine influences reworked the gulfward edge of the delta into a series of barrier headlands. As the shoreline along the GOM matured, and as the marshes behind the shoreline broke up and eventually disappeared, the barrier headlands transitioned into barrier islands.

Figure 4-2 presents the three-stage geomorphic model that summarizes the genesis and evolution of transgressive depositional systems in the Mississippi River Deltaic Plain (USACE, 2004a).

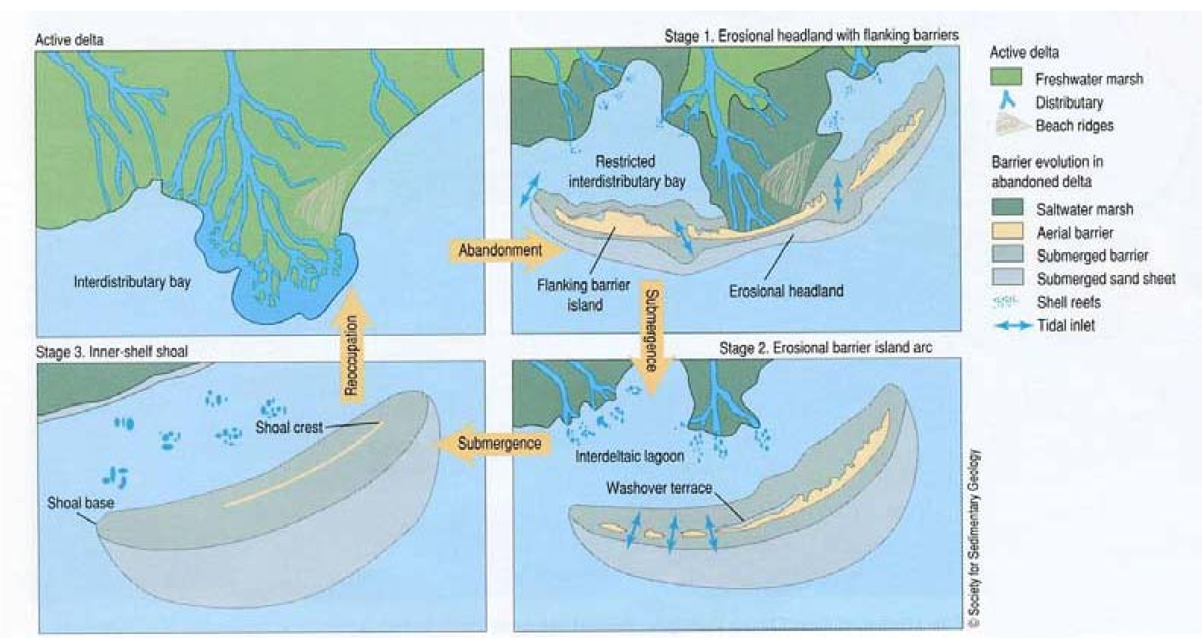

Figure 4-2. Three-stage geomorphic model.

As the marsh degraded further, open bays formed behind the barrier islands. Eventually, complete submergence and marine reworking of the islands created sand-rich marine shoals detached from the coastline, such as today's Ship Shoal, which is located on the mid-central Louisiana coastal shelf.

Delta development and degradation occurred simultaneously, with some portions of the Louisiana coast experiencing land gain, while other areas experienced land loss. However, the net effect of this process was the creation of land across the Deltaic Plain. The dynamic nature of these geologic and hydrologic processes provided for an extremely diverse and highly productive wetland ecosystem in the coastal area (USACE, 2004a).

Thus, Louisiana's barrier islands are the product of Mississippi River channel switching over the last 5,000 years. Each time the river relocated, the delta became subject to deteriorative forces. The barrier islands are the furthest gulfward expression of those deltas and the barrier islands consist of the most resistant river deposited materials. For barrier shorelines, complex interactions between storm events, longshore sediment supply, coastal structures, and inlet dynamics contribute to the erosion and migration of beaches, islands, and chenieres (beach ridges) (USACE, 2004a).

Subsidence:

Land elevations decrease due to subsidence from compaction and consolidation of sediments, faulting, groundwater depletion, and sub-surface fluid extraction. Land elevations increase due to sediment accretion from riverine and littoral sources and organic deposition from vegetation. Vertical accretion in the majority of the Study Area is insufficient to offset subsidence, decreasing land elevations. Based on NOAA's (http://tidesandcurrents.noaa.gov) current mean sea-level (MSL) trend at Grand Isle, LA of 9.24 mm/yr and global MSL rise of 1.7 mm/yr (USACE, 2009b), the subsidence rate in the LCA TBBSR Study Area is estimated at 7.54 mm/yr.

Topography:

Isle Dernieres Reach

The Isles Dernieres barrier island reach stretches for over 15 miles along the Louisiana coast, approximately 63 miles west of the mouth of the modern Mississippi River and about 75 miles southwest of New Orleans, Louisiana (Figure 1-1). The present configuration of this island reach includes the following islands, from west to east: Raccoon Island, Whiskey Island, Trinity Island, and East Island, along with the remnants of Wine Island. The islands are separated by the following passes: Coupe Collin, Whiskey Pass, Coupe Juan, and Wine Island Pass.

The average long-term (1887–2002) rate of shoreline change for the Isles Dernieres was -34.7 ft/yr with a range of -56.0 to -17.0 ft/yr. The average short-term (1988–2002) rate of shoreline change was -61.9 ft/yr with a range of -86.0 to -38.6 ft/yr (USACE, 2004c). Table 4-2 presents a summary of acreage and erosion rates for all of the islands in the Isles Dernieres Reach. Shoreline change for the Isles Dernieres is graphically presented in Figure 4-3.

Table 4-2. Summary of Acreage and Erosion Rates for the Isles Dernieres (Barras, 2009; USACE, 2004c)

Island	Acreage in 2008	Short-term Erosion Rate (ft/yr)	Long-term Erosion Rate (ft/yr)	Historic Erosion Rate (ft/yr)
Raccoon Island	121	-60.5	-28.6	-27.4
Whiskey Island	509	-86.0	-42.7	-56.0
Trinity Island	630	-62.5	-39.7	-38.4
East Island	300	-38.6	-39.7	-17.0
Wine Island	12	N/A	-21.6	N/A

N/A denotes data not available

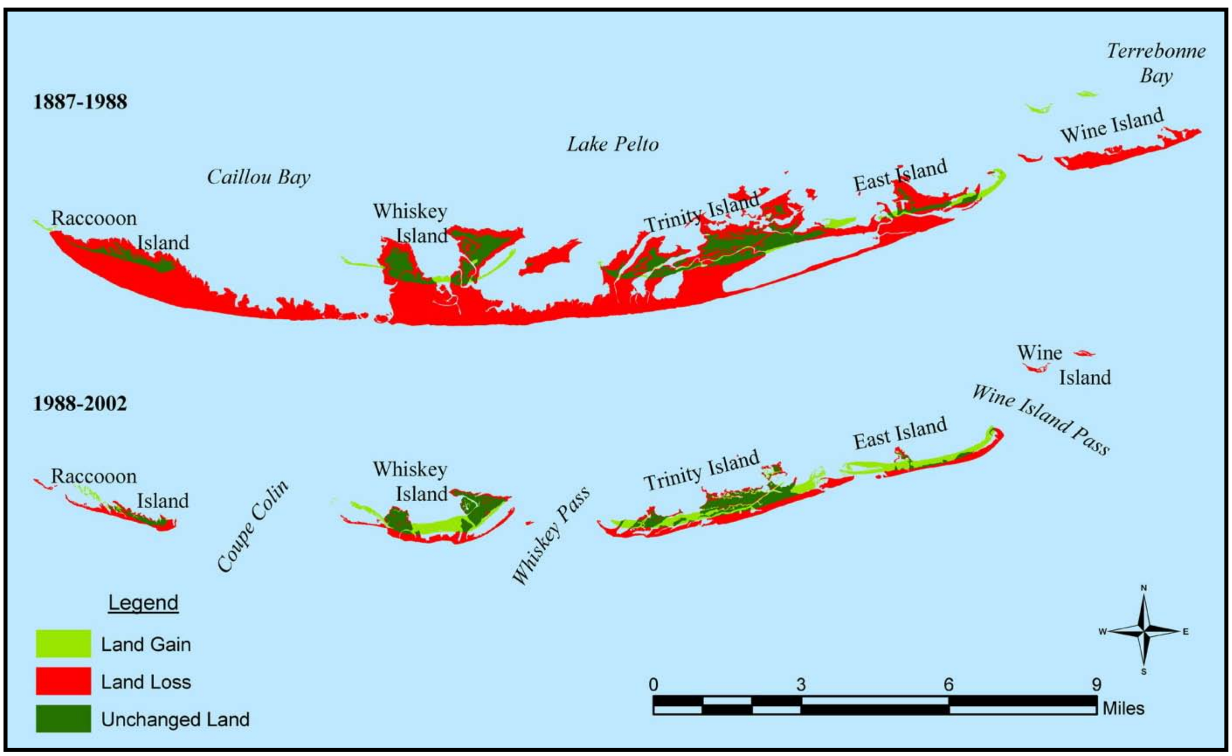

Figure 4-3. Short-term and Long-term Shoreline Change for the Isles Dernieres (USACE, 2004c)

<u>*Raccoon Island*</u>

Raccoon Island is approximately 2.6 miles long (USDA, 2007b) and is located at the western end of Isles Dernieres. It is the largest shorebird rookery in the Isles Dernieres. Raccoon Island is characterized by sandy beach with well-vegetated washover terraces backed by thick groves of black mangrove and salt marsh. The recurved spit at the west end is low and dominated by washover flats. The average historic shoreline change rate between 1887 and 2002 was -27.4 ft/yr with a range of -28.9 to -24.9 ft/yr. The average short-term shoreline rate was -60.5 ft/yr with a range of -144.5 to -8.6 ft/yr between 1988 and 2002. It is noted the average shoreline change rate increased over time, specifically from -27.4 ft/yr to -60.5 ft/yr during the two time periods, 1887 to 2002 and 1988 to 2002, respectively (USACE, 2004c). The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana (William et al., 1992) was -28.6 ft/yr.

Since 1978, Raccoon Island rapidly decreased in area from 368.2 to 200.2 acres between 1978 and 1988. During this time period, multiple hurricane impacts occurred in 1979 (Bob and Claudette) and 1985 (Danny, Elena, and Juan). From 1988 to 1992, Raccoon Island further decreased in area from 200.2 acres to 167.8 acres. With the impact of 1992's Hurricane Andrew, the area of Raccoon Island continued to decrease even further to 112.8 acres. By 1993, Raccoon Island had further reduced in area to 99.2 acres. The FEMA restoration project of 1994 increased the size of Raccoon Island to 127.2 acres by 1996. The CWPPRA TE-29 segmented breakwater project further increased the area of Raccoon Island to 145.5 acres by 2002. While the hurricane impacts in 2005 (Katrina and Rita) caused erosion, the breakwaters continued to benefit the island (USACE, 2004c). Though an increase in acreage was observed in 2006 (215 acres), the effects of Hurricanes Gustav and Ike reduced Raccoon Island to 121 acres by the winter of 2008 (Barras, 2009).

Whiskey Island

Whiskey Island is located near the middle of five islands in the Isles Dernieres barrier island reach. It is approximately 4.6 miles long (USDA, 2007b) and located approximately 17.5 miles southwest from Cocodrie, Louisiana in Terrebonne Parish. The average historic shoreline change rate between 1887 and 2002 was -56.0 ft/yr with a range of -77.5 to -45.7 ft/yr. The average short-term shoreline change rate was -86.0 ft between 1988 and 2002 with a range of -139.4 to -48.4 ft/yr (USACE, 2004c). The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana (William et al., 1992) was -42.7 ft/yr.

Prior to restoration, the morphology of Whiskey Island was dominated by washover flats and isolated washover terraces. The CWPRRA restoration project (TE-27) at Whiskey Island created an artificial dune +4 to +6 ft in elevation, which was 2 to 3 ft above the natural pre-restoration surface. As seen throughout the Isles Dernieres, Whiskey Island is historically erosional and decreasing in area. Between 1978 and 1988, Whiskey Island decreased in area from 904.4 acres to 564.2 acres. The hurricanes of 1979 and 1985 were contributing factors to the decrease in area. By 1992, Whiskey Island had decreased to 505.6 acres. During the 1992 hurricane season, Hurricane Andrew impacted this area dramatically, reducing Whiskey Island to 440.8 acres. By 1993 it had further decreased in area to 428.4 acres. Post storm recovery processes increased the area of Whiskey Island to 474.8 acres by 1996. Construction of the Whiskey Island project (TE-27) began in February 1998 and was completed in August 1998. By 2002, the area of Whiskey Island had increased to 642.8 acres, a 36% increase in area. While the hurricanes in 2005 impacted the island, overwash processes and longshore sediment transport from Trinity and East Islands benefited Whiskey Island (USACE, 2004c). The effects of Hurricanes Gustav and Ike decreased the area of Whiskey Island to 509 acres by the winter of 2008 (Barras, 2009).

Trinity Island

Trinity Island, the largest island of the Isles Dernieres, is approximately 5.2 miles long (USDA, 2007b) and lies immediately to the east of Whiskey Island. The morphology includes low dune terraces, with isolated dunes of up to 3 to 4 ft in elevation. Overwash is more frequent at the west and east ends of the island where elevations decrease. It is a remnant of the original mainland marsh and well-vegetated by black mangroves and salt marsh species. Trinity Island is historically eroding. Between 1978 and 1988, Trinity Island decreased in area from 1,317.1 acres to 894.6 acres. This was a time period of multiple hurricanes in occurring in 1979 and 1985. By 1992, Trinity Island further decreased to 796.5 acres. During the 1992 hurricane season, Hurricane Andrew impacted this area, reducing Trinity Island to 678.5 acres and by 1993, the island decreased further to 651.4 acres. By 1996, the area of Trinity Island continued to decrease to 617.4 acres. Trinity Island increased in area from 617.4 to 710.1 in 2002 as a result of a restoration project constructed on the western end of the islands (USACE, 2004c). Though the impacts of Hurricanes Katrina and Rita were offset by the New Cut Project in 2006 (increasing Trinity Island to 764 acres), the effects of Hurricanes Gustav and Ike decreased the total area of the island to 509 acres by 2008 (Barras, 2009).

The average historic shoreline change rate between 1887 and 2002 was -38.4 ft/yr with a range of -47.9 to -34.3 ft/yr. The 1988 to 2002 average short-term change rate was -62.5 ft/yr with a range of -107.3 to -41.1 ft/yr. The acceleration between the long-term and short-term shoreline change rates is linked to the major hurricane impacts of 1992 and 2002 (USACE, 2004c). The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana (William et al., 1992) was -39.7 ft/yr.

East Island

East Island is approximately 3.1 miles long (USDA, 2007b) and is the easternmost island of the Isles Dernieres. It is characterized by low dunes and washover terraces, with elevations ranging from +3 to +5 North American Vertical Datum 1988 (NAVD 88). Prior to restoration, East Island was rapidly eroding and decreasing in area since 1887. In 1978, East Island was 368.2 acres in area and by 1988 it had decreased in size to 202.2 acres. The average historic shoreline change between 1887 and 2002 was -17.0 ft/yr with a range of -34.6 to -5.1 ft/yr. Short-term, between 1988 and 2002, the average shoreline erosion rates accelerated to -38.6 ft/yr with a range of -64.0 to -14.0 ft/yr. During this period of time multiple hurricane impacts occurred in 1979 and in 1985. The 1985 impacts prompted island restoration efforts by way of the Terrebonne Parish Barrier Island Restoration Project (USACE, 2004c). The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana (William et al., 1992) was -39.7 ft/yr.

The East Island portion of this Study, which measured 3,200 ft long, 1,000 ft wide, and encompassed 38 acres, used sediment from the margins of Wine Island Pass to build foredunes to an average elevation of eight ft, and raised back barrier elevations by an average of 3.5 ft. Subsequent to sediment settling and leaching, vegetative planting was performed for island stability (Penland and Suter, 1988). By 1992, East Island had continued to lose land and measured 173.4 acres in size. After Hurricane Andrew made landfall in 1992, East Island was further reduced to 93.4 acres, and this continued into 1993 when East Island reached 88.5 acres in size. Following Hurricane Andrew, FEMA did an emergency restoration project east of the former Terrebonne Parish restoration site, resulting in East Island enlarging from 88.5 acres in 1993 to 193.1 acres in 1996. The CWPPRA East Island restoration was completed in 1998, and the area of the island increased from 193.1 acres to 380.4 acres by 2002 (USACE, 2004c). By 2008 East Island decreased to approximately 300 acres due to the hurricane impacts in 2005 and 2008.

<u>Wine Island</u>

Wine Island, located approximately 2.5 miles northeast of East Island and 3.9 miles west of Timbalier Island, lies on Wine Island Shoal, with Wine Island Pass to the west and Cat Island Pass to the east. Historically, Wine Island was the easternmost of the Isles Dernieres. It was approximately three miles in length, and located across the mouth of the present Wine Island/Cat Island Pass (Penland, et al., 2005). By the mid-20th Century the island had migrated north and eroded away. What is now called Wine Island is a dredge spoil disposal site, associated with the Houma Navigation Canal (HNC). In 1991 the present configuration was created when the South Terrebonne Tidewater Management and Conservation District (District) constructed the rock containment dike and the USACE filled it with dredge spoil from the HNC. The original restoration created a 24-acre island, approximately 1,500 ft, east to west. The island was vegetated with a mixture of cordgrass, black mangrove, and ryegrass by the District and the Coastal Restoration Division of the Louisiana Department of Natural Resources in the same year. In 1992 Hurricane Andrew overwashed the island, decimated the vegetation, and washed approximately one-third of the land away. Plans for additional rock structures, dredge spoil placement, and vegetation planting never materialized and responsibility for the island was transferred to the Louisiana Department of Wildlife and Fisheries.

The present island is small; approximately 800 ft in east-west dimension. The island is no longer contained within the revetment: its area has been reduced significantly and its footprint has migrated north such that about one third of it presently lies outside the subcircular ring of rocks. Whether the present land mass has been supplemented by subsequent dredge spoil disposal is unknown. Its low relief and sparse vegetation point to periodic overwash, as does its ongoing migration out of the encircling rock revetment. The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana (William et al., 1992) was -21.6 ft/yr.

The island is a thriving bird rookery. There is strong public sentiment, from Terrebonne Parish residents and Parish government, to protect and expand Wine Island.

Timbalier Reach

The Timbalier Islands are very dynamic island systems that form the eastern end of the Study Area and are migrating both landward and laterally. The Timbalier Islands are comprised of the Western and Eastern section of Timbalier and East Timbalier Island. Over the last century, Timbalier Island lost most of its area, shrinking from 3,580 acres to 1,349 acres; most of the loss occurred on the bayside. From 1978 to 1988, the island lost an average of 63 acres/yr as result of opposite rates of migration of Gulf and bayside shorelines, that is, the bayside shoreline migrated seaward while the Gulf shoreline migrated landward.

The average historic rates of shoreline change for the Timbalier Islands was -36.1 ft/yr with a range of -61.2 to -4.1 ft/yr between 1887 and 2002. The average short-term rate of shoreline change was -76.4 ft/yr with a range of -179.4 to -13.4 ft/yr between 1988 and 2002 (USACE, 2004c). Table 4-3 presents a summary of acreage and erosion rates for Timbalier and East Timbalier Islands. Shoreline change for the Timbalier Reach is graphically presented in Figure 4-4.

Historically, the Timbalier Islands have undergone large negative and positive area rate changes. Between 1887 and 1934 the area of the Timbalier Islands decreased from 4,142 acres to 2,875 acres at a rate of 27.0 acres/yr. Between the next two periods, 1934 to 1955 and 1956 to 1978, the Timbalier Islands increased from 2,875 acres to 3,280 acres to 3,693 acres at a rate of +18.8 acres/yr respectively. This was a period of extensive back-barrier canal dredging and dredge spoil placement to support oil and gas development that inadvertently increased the areas of the Timbalier Islands. The large decrease in the area between 1978 and 1988 is a function of the extension of the Belle Pass jetties to the east and the disruption of the dominant longshore sediment transport to the west (USACE, 2004c). The combination of a diminishing sediment supply and hurricanes continued to drive island barrier loss, reducing the Timbalier Islands to 1,354 acres by 2008.

Table 4-3. Summary of Acreage and Erosion Rates for the Timbalier Reach (Barras, 2009; USACE, 2004c)

Island	Acreage in 2008	Short-term Erosion Rate (ft/yr)	Long-term Erosion Rate (ft/yr)	Historic Erosion Rate (ft/yr)
Timbalier Island	1,112	-96.4*	-32.5	-23.5*
East Timbalier Island	242	-36.3	-21.4	-61.2

*Averaged erosion rates for Western and Eastern sections of Timbalier Island

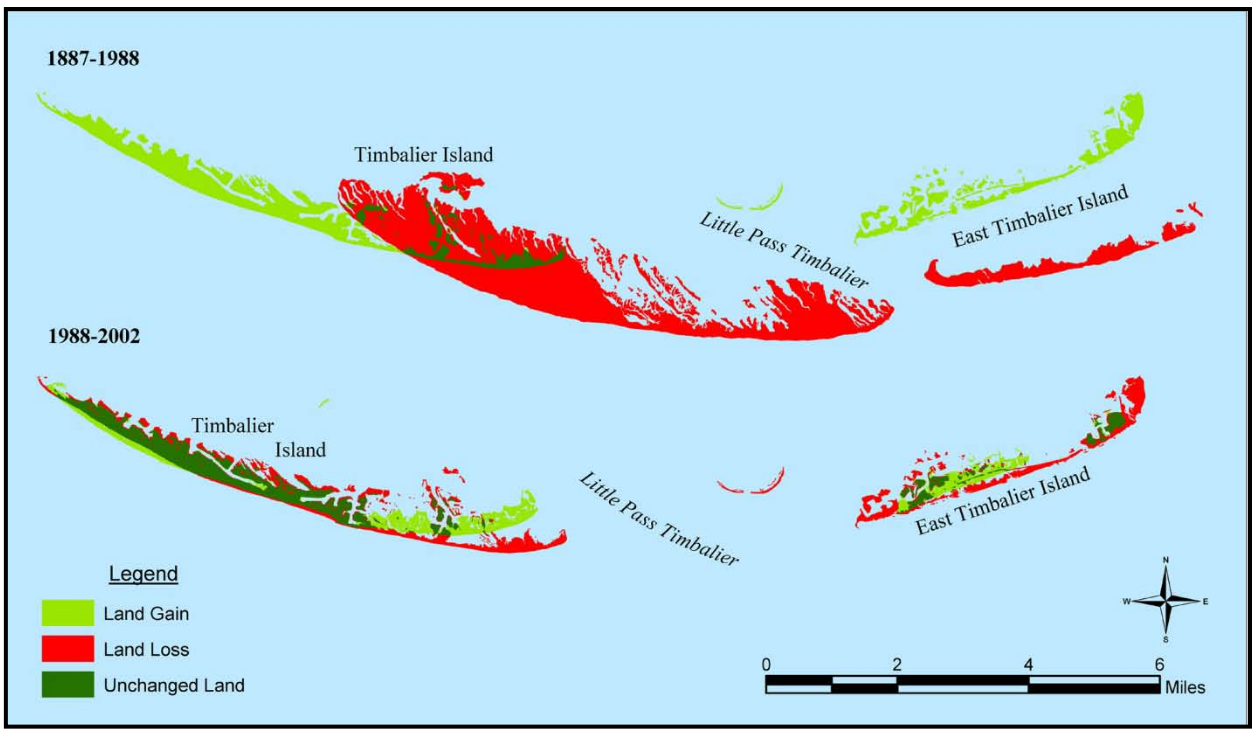

Figure 4-4. Short-term and Long-term Shoreline Change for the Timbalier Reach (USACE, 2004c)

Timbalier Island

Timbalier Island is approximately 7 miles long (USDA, 2007b) and lies in Terrebonne and Lafourche Parishes. Historical maps of shoreline change have provided insight into the erosion process during the rapid westward migration by Timbalier Island. Over the last 115 years, Timbalier Island has migrated 2.5 miles to the west by the erosion of its east end and the recurve spit extension of its west end. With this westward migration, Timbalier Island has developed two distinct shoreline change rate regimes (USACE, 2004c).

The average historic rate of shoreline change for the eastern portion of Timbalier Island was -42.9 ft/yr between 1887 and 2002 with a range of -48.6 to -37.3 ft/yr. Between 1988 and 2002, the average short-term erosion rate accelerated to -179.4 ft/yr with a range of -205.5 to -153.3 ft/yr for the eastern portion. The high rates of negative change reflect the impact of the 1992 and 2002 hurricanes. Conversely, with the western migration of Timbalier Island, the western portion of the island has historically shown a lower rate of shoreline change. The average historic erosion rate for the western portion is -4.1 ft/yr with a range of -31.0 to +20.9 ft/yr between 1887 and 2002. The western portion has experienced an average short-term erosion rate between 1988 and 2002 of 13.4 ft/yr with a range of -118.7 to +31.9 ft/yr. The combination of the 1985/1992/2002 hurricanes and disruption of the westward sediment transport by the Belle Pass jetties have all contributed to the high rates of shoreline change in this area (USACE, 2004c). The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana (William et al., 1992) was -32.5 ft/yr.

East Timbalier Island

East Timbalier Island is approximately 3.6 miles long (USDA, 2007b) and lies east of Little Pass Timbalier and directly west of the Bayou Lafourche headland. East Timbalier Island is occupied by a major oil and gas operation at the inshore Timbalier Bay Field. The island and surrounding bay supports major offshore production facilities. East Timbalier Island is known for the massive rip-rap seawall along its Gulf shoreline and numerous revetments landward of it. The combination of the position of East Timbalier Island immediately downdrift of the Bayou Lafourche headland and the Belle Pass jetties create one of the most erosional areas in coastal Louisiana (USACE, 2004c).

The average historic erosion rate between 1887 and 2002 was -61.2 ft/yr with a range of -74.3 to -49.2 ft/yr. The average short-term erosion rate between 1988 and 2002 decreased to -36.3 ft/yr with a range of -65.5 to -4.9 ft/yr. The erosion rate diminished here in spite of the 1992 and 2002 hurricanes. This shoreline erosion decrease is partially related to the construction of CWPPRA restoration project TE-25/30 in 2000, which created approximately 109 acres of new land (USACE, 2004c). The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana (William et al., 1992) was -21.4 ft/yr.

4.2 SIGNIFICANT RESOURCES

4.2.1 Soils and Water bottoms

4.2.1.1 Soils

The deltaic and chenier plains of coastal Louisiana consist of soils that can be divided into six primary associations. These soils are primarily mineral deltaic, or mineral coastal deposits formed from alluvial or aeolian processes. The soils that exist nearest to the coast may also be formed or deposited by marine processes and sediments. The six coastal associations often contain soils with organic matter in the upper horizon, or throughout the whole profile (USACE, 2004b).

Soils in the Study Area are characterized by the depositional environments associated with the deltaic cycle. These soils are formed or deposited by marine processes and sediment (USACE, 2004b). The seaward edges of these islands are typically linear or curvilinear forms consisting of loamy fine sand (fluid mineral soils) formed by means of marine reworking. The back-barrier saltwater marshes consist of level, very poorly drained soils that have a mucky surface layer (high levels of organic matter), and a mucky or clayey underlying material (USDA, 2007a).

Specific geotechnical investigations including test borings were conducted on the islands as part of the CWPPRA project designs. For Whiskey Island, auger borings taken on the beach and dune revealed fine sand with shell fragments while the back-bay and marsh borings indicated soft clays and silty clays with lenses of sand, silt and shell comprised the upper 65 ft, and were underlain by medium stiff pro-delta clays with silt and sand lenses (LDNR, 2007). On Raccoon Island, the results of the test borings indicated that generally the soils are loose sands underlain by weak compressible clays to depths of over 100 ft. The upper 12 to 15 ft was classified as fine sand and silt, underlain by soft clays and silty clays to 50 ft (NRCS, 2007). These soil types are characteristic of the Terrebonne Basin barrier islands.

Prime or Unique Farmlands are not present in the Study Area.

4.2.1.1.1 Historic Conditions

Deltaic processes have played a significant role in the types of soil present in the Study Area. The dynamic and episodic deltaic building processes alternates between periods of seaward progradation of deltas (regressive deposition) and the subsequent landward retreat of deltaic headlands as deltas are abandoned, reworked, and submerged by marine waters (transgressive deposition). The types of soils present today in much of the Study Area are characterized by the depositional environments associated with both of these phases of the deltaic cycle.

4.2.1.1.2 Existing Conditions

Isles Dernieres soils have been identified as Felicity and Scatlake soil units (USDA Soils Survey, 2005). Felicity soil is a level to gently sloping, somewhat poorly drained soil, which is formed in the sandy beach rim/dune complex along the Gulf of Mexico shoreline. The soil is frequently flooded, and subject to scouring and deposition by storm surge and sediment. The surface layer of Felicity soil is typically grayish brown, loamy fine sand that extends to a depth of approximately nine inches. The underlying material, dark gray loamy sand is typically measured to a depth of approximately 60 inches (USDA Soils Survey, 2005).

The soils of Timbalier and East Timbalier Islands are similar to those found on Isles Dernieres in that they are composed primarily of fine-grained, poorly developed sands. The Felicity soils are classified as poorly drained, rapidly permeable, saline sands in the beaches, dunes, and overwash regions, while the Scatlake soils are mucky clays that are primarily located in the saline marshes (USDC, 1998). The nearshore features of Timbalier and East Timbalier Islands are flat compacted sand, with minor sandbar features in 6-8 ft of offshore water (USEPA, 2002).

The Scatlake unit is a level, very poorly drained, very mineral clay and muck soil that was formed on the level lee side of the island from the remnant intratidal deltaic marsh sediment. The surface layer, which is typically eight inches of dark gray, very fluid muck, is positioned above approximately 75 inches of underlying material that ranges from gray to dark gray muck, to very fluid clay (USDA, 2005).

4.2.1.2 Water bottoms

4.2.1.2.1 Historic Conditions

Beginning in the 1980s, the Louisiana Geologic Survey in conjunction with the USGS and MMS began investigating the distribution and character of sand-rich sediment within the shallow stratigraphy, (i.e., the upper 40 ft of the Study Area). Suter et al. (1991) and Kindinger et al. (2001) conducted in-depth regional studies of the offshore area. Combined, they collected thousands of miles of high-resolution seismic reflection data and hundreds of vibracores for the purpose of identifying and mapping sand-rich sediment resources.

The above referenced studies identified numerous inlet shoals and nearshore relict distributary channels sources and a significant offshore sand source at Ship Shoal. Potential nearshore sand sources include nearshore ebb-tidal shoals (e.g., Little Timbalier Pass, Coupe Collin, Cat Island Pass), relict spits (e.g., Raccoon Island paleo relict spits), and paleo distributary channels adjacent to the islands. These resources may also provide fine sediments for marsh restoration.

Potential sources of sediment for use in marsh restoration throughout the Study Area include channel dredging of the Houma Navigation Channel (about 350,000 cy per year from 1960 to 1980) and various sources adjacent to the Isles Dernieres Islands (Figures 4-5 and 4-6, and Table 4-4; Suter and Penland, 1988; and Suter et al., 1991). Kindinger et al. (2002) documented sand resources in the back bays and in the channels west of East Timbalier Island. Considerable knowledge has been gained through back-barrier and inlet geotechnical work in association with the Terrebonne Basin CWPPRA projects described in Section 1.5 "Prior Studies, Reports, and Existing Projects".

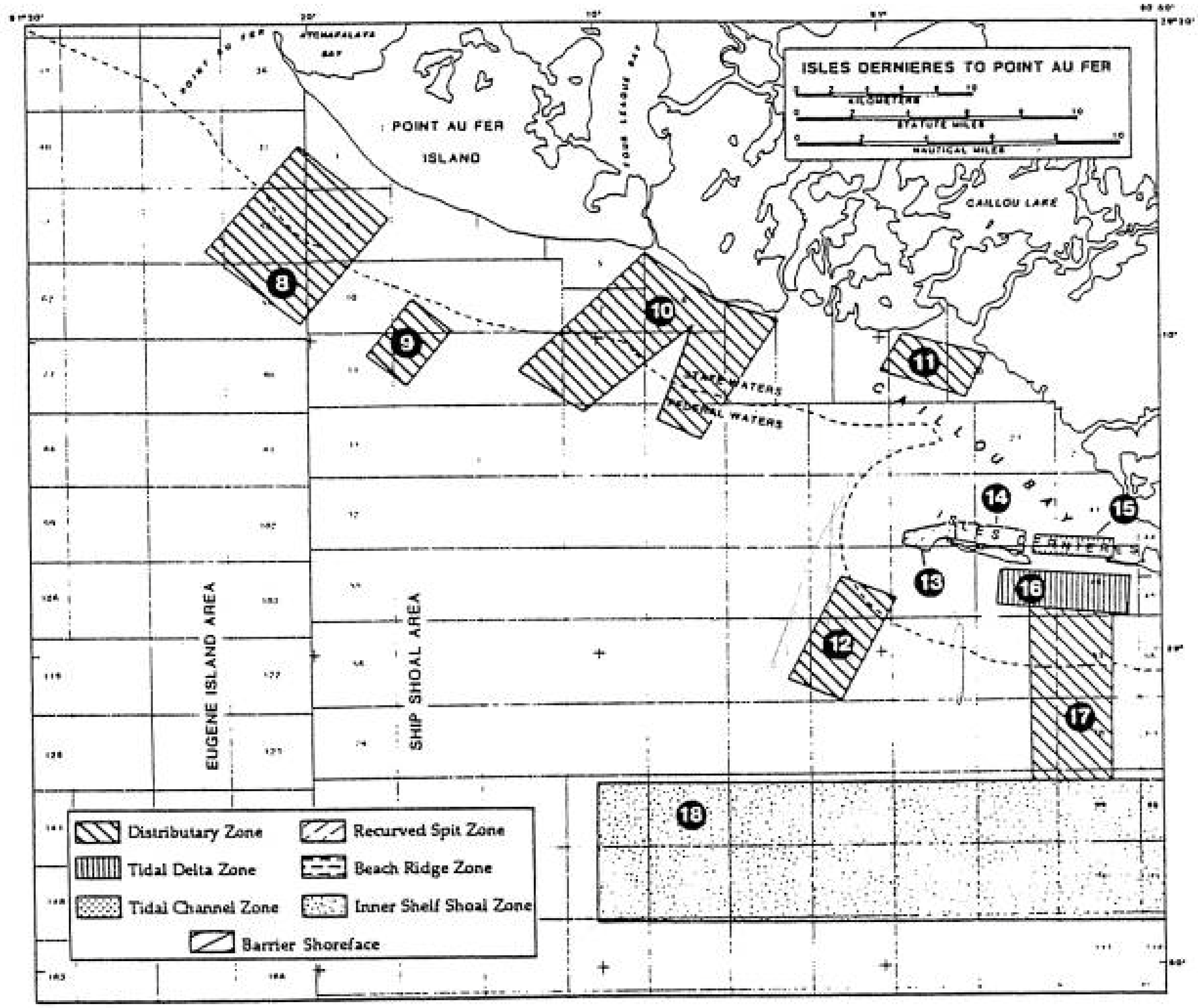

Figure 4-5. Locations of sediment resource targets in the area from Point au Fer to the Isles Dernieres (Suter et al., 1991)

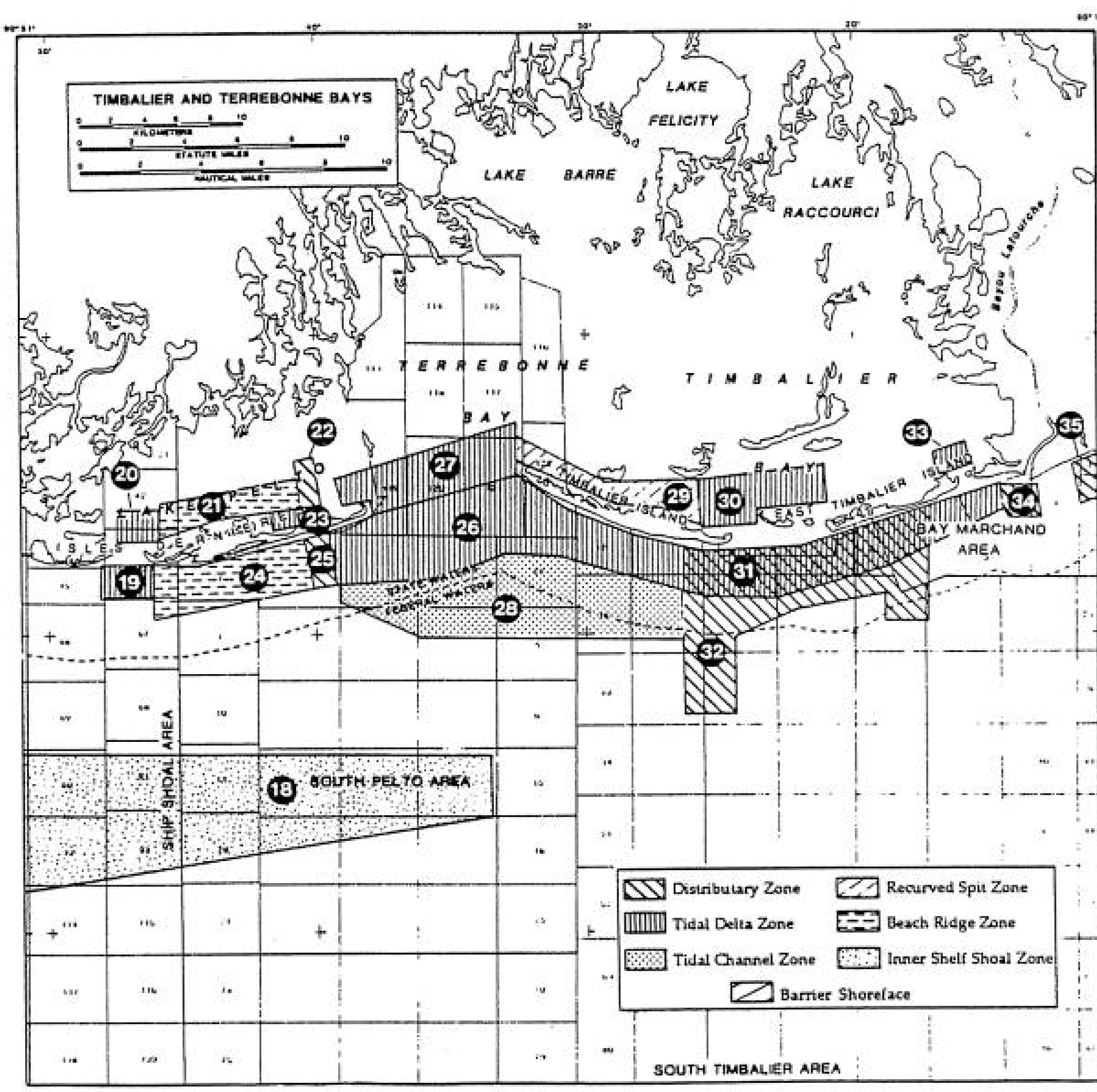

Figure 4-6. Locations of sediment resource targets in the Timbalier and Terrebonne bays area (Suter, et al., 1991)

Table 4-4. Sediment resources targets

Target Number	Designation	Target Number	Designation
1	Marsh Island Distributary Channel	29	Timbalier Island Recurved Spit
2	Western Shell Reef Distributary Channel	30	Little Pass Timbalier Flood Tidal Delta
3	Central Shell Reef Distributary Channel	31	Little Pass Timbalier Ebb Tidal Delta
4	Eastern Shell Reef Distributary Channel	32	Timbalier Island Distributary Channels
5	Marsh Island Shoal 1	33	Raccoon Pass Flood Tidal Delta
6	Marsh Island Shoal 2	34	Belle Pass Distributary Channel
7	Southern Shell Reef Distributary Channel	35	Bayou Lafourche Distributary Channel
8	Western Point Au Fer Distributary Channel	36	Bayou Moreau Distributary Channel
9	Central Point Au Fer Distributary Channel	37	Cheniere Caminada Beach Ridges
10	Eastern Point Au Fer Distributary Channel	38	Caminada Pass Spit
11	Grand Caillou Distributary Channel Ebb delta	39	Caminada Pass Ebb Tidal Dclta
12	Raccoon Point Distributary Channel	40	Grand Isle Shoreface
13	Raccoon Point Recurved Spit	41	Barataria Pass/Grande Terre Tidal Channels
14	Relict Raccoon Point Recurved Spit	42	Barataria Pass Ebb Tidal Delta
15	Coupe Colin Flood Tidal Delta	43	Pass Abel Ebb Tidal Delta
16	Coupe Colin Ebb Tidal Delta	44	Quatre Bayou Pass Ebb Tidal Delta
17	Ship Shoal Distributary Channel	45	Cheniere Ronquille Distributary
18	Ship Shoal	46	Cheniere Ronquille Beach Ridges
19	Whiskey Pass Ebb Tidal Delta	47	Bayou Chaland Distributary Channel
20	Whiskey Pass Flood Tidal Delta	48	Chaland Pass Ebb Tidal Delta
21	Lake Pelto Beach Ridges	49	Grand Bayou Distributary
22	Lake Pelto Distributary Channel	50	Grand Bayou Pass Ebb Tidal Delta
23	Coupe Carmen Flood Tidal Delta	51	Shell Island Distributary Channel
24	Cheniere Caillou Beach Ridges	52	Western Scofield Bay Distributary Channel
25	Caillou Distributary Channel	53	Central Scofield Bay Distributary Channel
26	Cat Island Pass Ebb Tidal Dclta	54	Eastern Scofield Bay Distributary Channel
27	Cat Island Pass Flood Tidal Dclta	55	Dry Cypress Bayou Distributary Channel
28	Cat Island Pass Tidal Channel		

4.2.1.2.2 Existing Conditions

Existing information and data related to potential sediment sources for beach, dune, and marsh restoration in the Terrebonne Basin barrier island reach were identified in the 2004 LCA Plan Appendix D (USACE, 2004c) and the final programmatic EIS (USACE, 2004b). Supplementing the information in these reports are additional environmental and geologic assessments, engineering reports, geotechnical surveys and geophysical surveys (Finkl et al., 2005; Khalil et al., 2006; Khalil et al., 2007; Kulp et al., 2001; LDNR, 2005b; LDNR and USEPA, 2007; Stone et al., 2004; USEPA, 2003a; and USEPA, 2003b). These data use geophysical and geotechnical methods to assess geologic resource areas for offshore sand sources and provide the geospatial extent of potential sediment sources for back-barrier and marsh restoration using numerous core borings.

More recently, details of sand sources offshore of Whiskey Pass and Trinity Island are reported in LDNR and USEPA (2007). Area 3 has an estimated 4.7 mcy of sand available for beach restoration while New Cut still has approximately 2.5 mcy available (S. Khalil, personal communication, August, 2008).

Ship Shoal, a large shore-parallel sand body, is located approximately from 11 to 32 miles from the barrier islands depending upon the specific fill area and lease block location. It represents a defined source for the long-term maintenance for Isles Dernieres and Timbalier Islands. Ship Shoal is the largest sand source in the Terrebonne Basin and testing (LDNR, 2005a; USEPA 2003a and 2003b) has shown sediment to be similar in quality to the native beaches and dunes of the Isles Dernieres and Timbalier Reaches. With the proximity of the shoal to the Isles Dernieres Reach, sand could be dredged and delivered to the coast by pipeline dredges equipped with booster pumps. For the Timbalier Reach, sand could be dredged and delivered via hopper dredges and pump-outs.

Sediments found in Ship Shoal vary based on stratigraphic position. Sediments in the upper 16 ft (5 m) of the shoal (shoal crest) are comprised by very well sorted quartz sand. The lower shoal (shoal front) ranges from 4 to 11 ft (1.2 to 3.4 meters) thick and contains finer-grained sand compared to the shoal crest. The base of the shoal contains poorly sorted finer-grained sand mixed with layers of silt and clay (Penland et al. 1988 from Stone et al. 2004).

Kulp et al. (2001) stated large areas of Ship Shoal are also the sites of extensive hydrocarbon infrastructure, presenting a technical difficulty for the efficient removal of sediment. Suggested areas of sediment removal were offshore lease blocks Ship Shoal 88, Pelto 12, and Pelto 13. Volumes, not considering the presence of infrastructure within these blocks, were estimated at 74 mcy, 58 mcy, and 44 mcy, respectively (Figure 4-7).

In association with MMS, recent studies have been conducted to establish a buffer zone around oil infrastructure and other magnetic anomalies within the Ship Shoal sand resource areas to ensure quality of borrow sediments and safety of dredging operations (Michel, 2004; and Nairn et al., 2004). During 2003, detailed geotechnical investigations were conducted to more accurately evaluate sand volumes that are potentially available for coastal restoration within Ship Shoal Blocks 88 and 89 and South Pelto Blocks 12 and 13 (USEPA, 2003a and 2003b).

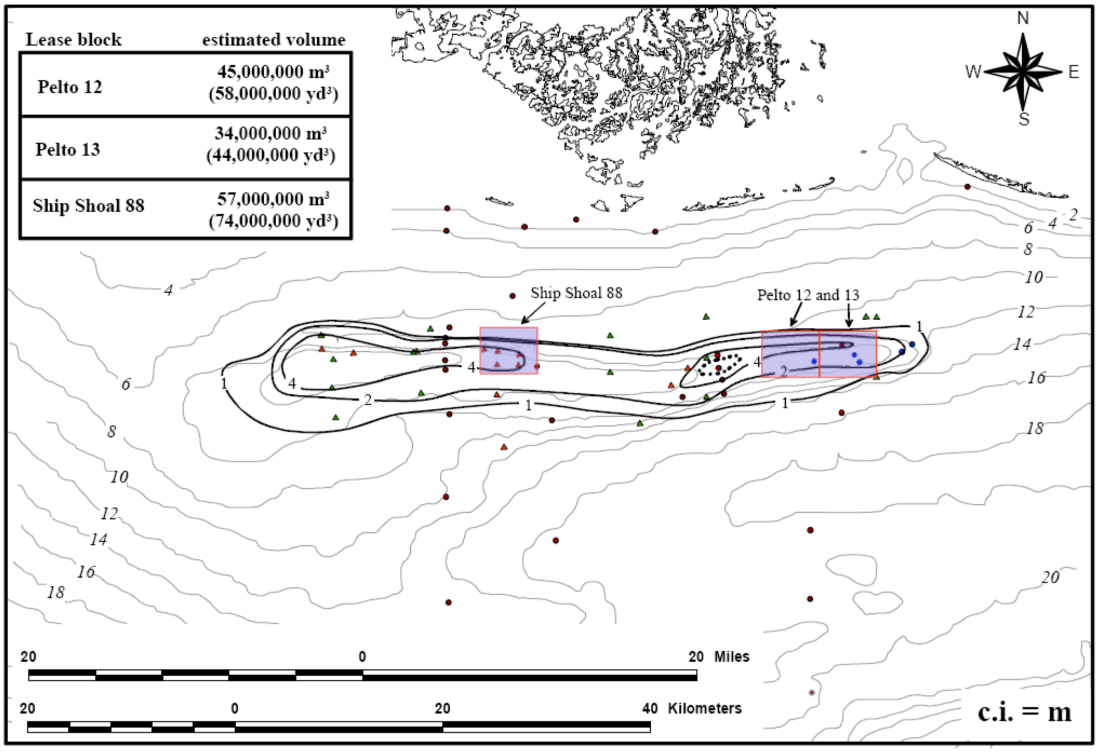

Figure 4-7. Ship Shoal Sand Resource (Kulp et al., 2001)

In South Pelto, Blocks 12 and 13, analyses of over 410 line miles of geophysical data and geotechnical exploration identified primarily clean sand (D50 grain size 0.15 to 0.2 mm) with less than 5% silt in upper stratigraphic units that ranged in thickness from approximately 13 to 20 ft over an area of about 10.4 mi^2. Combined volumes of three closely spaced potential borrows, which occupy portions of five MMS lease blocks, amounted to approximately 28.3 mcy (Khalil et al., 2007; and Finkl et al., 2005).

During July 2006, LDNR and the Louisiana State University (LSU) Coastal Studies Institute (CSI) for the first time conducted a reconnaissance geophysical survey (report under preparation) over Ship Shoal Blocks 85, 86, 98, and 99. Subsequently during July/August 2007, additional geophysical data were collected from this portion of Ship Shoal to ascertain and confirm several magnetic anomalies. On the basis of this reconnaissance geophysical survey, it was estimated that approximately 124 mcy is available to a depth of approximately 13 ft.

4.2.2 Hydrology

This resource is institutionally significant because of the National Environmental Policy Act (NEPA); Clean Water Act; Flood Control Act of 1944; Coastal Barrier Resources Act; Rivers and Harbors Act of 1899; River and Harbor and Flood Control Act of 1970; Watershed Protection and Flood Prevention Act; Submerged Land Act; Coastal Zone Management Act; Safe Drinking Water Act; Estuary Protection Act; Resource Conservation and Recovery Act (RCRA); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and Executive Order 11988 Floodplain Management. This resource is technically significant because Civil Works water resources development projects typically impact (positively or negatively) the interrelationships and interactions between water and its environment. This resource is publicly significant because the public demands clean water, hazard-free navigation, protection of estuaries and floodplains.

The Terrebonne Basin drainage area encompasses approximately 1,455 square miles. Major navigation channels within the basin are the Atchafalaya River, Wax Lake Outlet, Houma Navigation Canal, Gulf Intracoastal Waterway (GIWW), and Lower Atchafalaya River (LOSCO, 1999). These navigation channels introduce and/or compound marine influences in many of the interior coastal wetlands and water bodies within the Terrebonne Basin (USACE, 2004a).

4.2.2.1 Flow and Water Levels

4.2.2.1.1 Historic Conditions

The Mississippi River and its distributaries historically provided immense volumes of land-building sediment and nutrients throughout Louisiana's coastal areas. Levee activity along the Mississippi River in coastal Louisiana began as early as the 1700s. By the early 1900s the levee system along the Mississippi River was nearly complete protecting the surrounding areas by reducing the number of overbank flooding events. A consequence of this construction was that most of Louisiana's coastal wetlands were deprived of the sediment rich floodwaters and nutrients that help sustain the surrounding wetlands against land loss and subsidence. The flood protection afforded by the levee system allowed for increased economic development and human habitation in the coastal areas. With this development came the construction of roads, railways, ports and harbors, oil and gas access canals within the wetlands, and drainage projects. All of the activities lead to the disruption of the deltaic cycle and natural hydrology to a point where the land being lost exceeded the land created through natural processes (USACE, 2004a).

The coastal water level patterns within the LCA TBBSR Study Area is typically a diurnal tidal signal of 30–40 cm (12–16 in) which), which is superimposed on a lower frequency (~3 days), higher amplitude (up to 1 meter) signal. The tidal fluctuations explain 60–70% of the water level variations. The lower frequency signal is mainly due to atmospheric forcing events (frontal passage). In general, the coastal water levels exhibit ~1 m (3.2 ft) of movement throughout the year (tides and fronts combined). The tidal amplitude decreases as one moves inland.

Water levels surrounding the barrier islands are primarily controlled by tides and winds. Smaller contributing factors are wave action, freshwater run-off from the marshes in the northern section of the basin, and to a lesser degree, atmospheric pressure. Wind-driven set-up can alter water levels to a greater extent than tides, which are diurnal and of low magnitude in this area. The maximum tidal range is about two ft (0.6 m).

4.2.2.1.2 Existing Conditions

The Terrebonne Basin wetland communities experience different hydrological influences. The eastern portions of the basin are hydrologically isolated from the influence of the major sediment rich waters of the Atchafalaya and Mississippi Rivers. The same is true for the northwestern portions, both above and below the GIWW, where the hydrologic influence comes mainly from a widely variable pattern of Atchafalaya River backwater effect, rainfall runoff events, and marine processes. Conversely, the southwestern portion of the basin receives nourishment from the Atchafalaya River and has some of the lowest land loss rates in the State (USACE, 2004a).

The present LCA TBBSR Study Area still maintains most of the features of typical natural estuaries. Even though the changes in hydrology, salinity and marshes have been severe, there is still a fresh to salt gradient, flow across many marshes, and an active fish and shellfish nursery—important aspects of estuarine function and integrity.

The tidal range near the barrier islands is relatively small compared to areas along the east and west coast. The average range is on the order of 1 ft with a fortnightly maximum range of 1 to 2 ft. Frontal passages can increase the normal tidal range up to 2 ft and storm surges associated with tropical storms and hurricanes can reach magnitudes several times the normally encountered range. Hurricane storm surge will typically be on the order of 3 to 4 ft once every 10 years and 7 ft once every 20 years (USEPA, 1997a).

Waves

The wave climate along the Louisiana coast is a product of seasonal wind patterns and the passage of tropical and extra-tropical storms. The distribution of deepwater wave energy is known from several NOAA stations that are located between 22 and

118 miles offshore. The nearshore wave climate is less well known, and comes primarily from data sets that are collected at Wave Current Information System (WAVCIS) stations, an observing system along the Louisiana continental shelf operated by the Louisiana State University, Coastal Studies Institute (CSI).

Deepwater Waves

Deepwater wave characteristics for central Terrebonne Basin were collected from NOAA Station 42017. The station is located approximately 68 miles offshore where the water depth is approximately 2000 ft. The period of record for the significant wave height and dominant wave period information is 1 year, 1989. The data indicates an average deepwater wave height of 2.5 ft and an average wave period of 5 seconds (USACE, 2004c). NOAA Station 42001, which is located 180 nautical miles south of Southwest Pass, La in 3246 meters of water has a period of record from January 1976 to December 2001. At this station, the monthly mean significant wave height ranged from approximately 1.6 ft to 4.6 ft and mean wave periods ranged between approximately 4.1 to 5.0 seconds (NOAA, 2009).

Nearshore Waves

The following nearshore waves information is incorporated by reference from Appendix D – Louisiana Gulf Shoreline Restoration Report – of the Louisiana Coastal Area (LCA) Ecosystem Restoration Study (per NEPA Section 1502.21; USACE, 2004c).

The nearshore WAVCIS station for Terrebonne Basin, CSI-5, is located approximately 1.2 miles offshore of Timbalier Island approximately at the 16-ft isobath. Wave and wind rose data for Station CSI-5 (Figure 4-8) depicts seasonal variation in wave climate for the central Louisiana coast. The data demonstrate a high correspondence between dominant wave approach and wind direction. For the period between mid-spring and mid-fall, winds are predominantly from the south, with the highest frequency of occurrence from the southeast. The dominant wave approach is from the southeast quadrant (40% probability). During late fall to early spring, the wind regime is controlled by the passages of cold fronts. These weather systems commonly produce winds blowing from the south (pre-frontal) and then from the north (post-frontal). However, the northeasterly winds blow offshore in central Louisiana, which cancels propagation of longer waves from the south near the coast. The fetch to the north of Station CSI-5 is limited, and waves are not generated during these post-frontal events. Therefore, the dominant waves (probability ~ 80%) come from the southeast quadrant and are the chief control of sediment transport patterns along the central Louisiana shoreline. Data from the same WAVCIS station, CSI-5, illustrates the seasonality in wave energy in Louisiana (Figure 4-9). These graphs represent time series of wave height from May through August 2001 as measured by CSI-5. The lower graph shows the wave height distribution at the same location for a winter period extending from November 2001 through February 2002.

Typically, waves vary from approximately 0.23 - 2.65 ft, the latter being a function of weak storms in the GOM. It is apparent, however, that tropical cyclones can generate considerably larger waves during summer months where waves over 6.2 ft in height were recorded for a period in early June, 2001. During winter months, the effects of cold front passages over the Louisiana coast are apparent in the graph as a series of sharp increases in wave height. During the four-month period from November 2001 to February 2002, a total of 20 cold front passages can be identified with six events resulting in energetic sea states and wave heights ranging from approximately 3.3 to 6.6 ft. Therefore, with the exception of infrequent tropical cyclone activity in summer months, the high frequency of frontal passages over the Louisiana coast plays a critical role in generating and sustaining higher waves during winter months (USACE, 2004c).

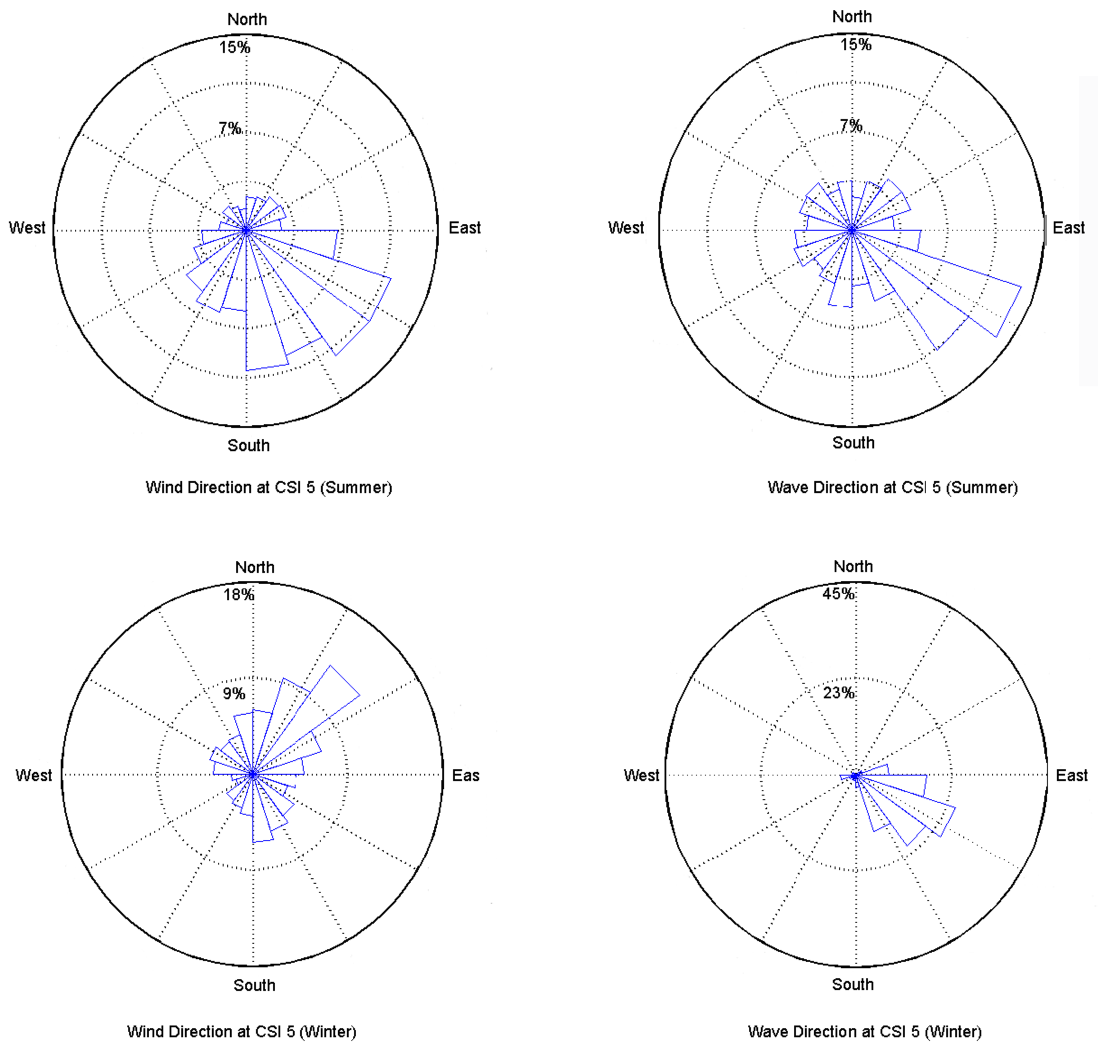

Figure 4-8. Wave (right) and Wind (left) Roses for data collected from WAVCIS Station CSI-5: Summer (top) and Winter (bottom) (USACE, 2004c)

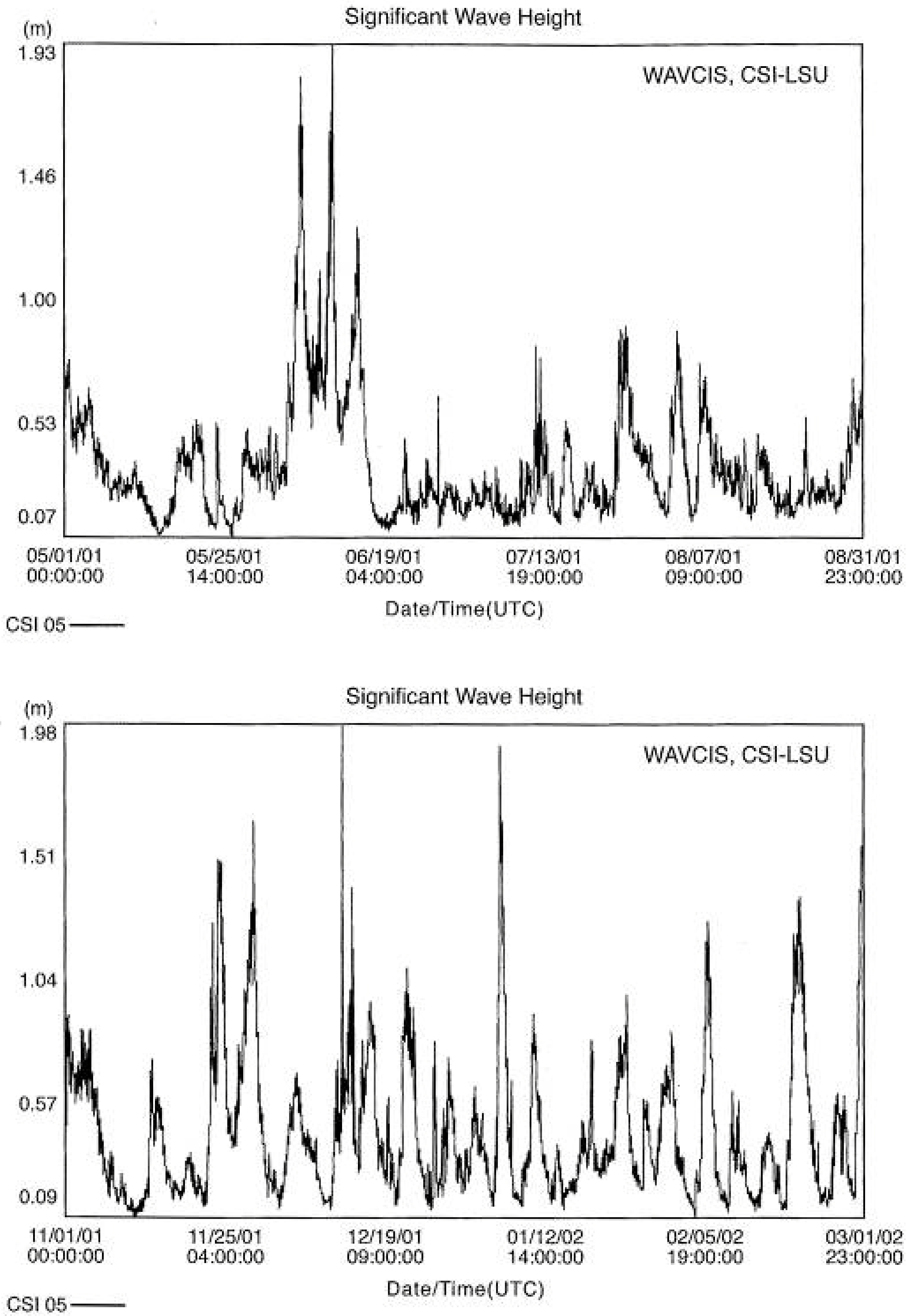

Figure 4-9. Time Series of Wave Height Data from WAVCIS Station CSI-5: Summer (top) and Winter (bottom) (USACE, 2004c)

Storms and Hurricanes

The following storms and hurricanes information is incorporated by reference from Appendix D – Louisiana Gulf Shoreline Restoration Report – of the Louisiana Coastal Area (LCA) Ecosystem Restoration Study (per NEPA Section 1502.21; USACE, 2004c). Penland and collaborators have analyzed changes in the Louisiana shoreline, spanning a century and a half (Penland, *et al.*, 2005). Their graphical presentations of land loss data clearly demonstrate the impacts of multiple hurricanes (1979, Bob and Claudette; 1985, Danny, Elena, and Juan; 1992, Andrew) on the Terrebonne Basin Barrier Islands, most of which lost hundreds of acres. The catastrophic losses from Andrew precipitated numerous restoration projects, sponsored by CWPPRA and FEMA. The hurricanes of 2005, Katrina and Rita, and 2008, Gustav and Ike, undid much of that repair work, and further degraded most of the islands.

Cold Fronts

In an average year, 20 to 30 cold fronts will pass through coastal Louisiana. The resulting response of the coastal waters is the initial increase in tidal amplitudes, which causes waves to break higher on the beach, overwashing low barrier islands. Elevated tides increase the flow of ocean water into the bays and marsh systems behind the barrier islands. As floodwaters reside and exit the inlets with passage of the front, abrupt changes in wind direction from southerly to northerly cause increased wave heights in the bays. This continuous process is believed to be responsible for the chronic shoreline erosion behind the barrier islands.

Tides

The following tides information is incorporated by reference from Appendix D – Louisiana Gulf Shoreline Restoration Report – of the Louisiana Coastal Area (LCA) Ecosystem Restoration Study (per NEPA Section 1502.21; USACE, 2004c).

In the delta region including Raccoon Pass (west), Grand Isle (central), and the northern Chandeleur Islands (east) tides are strongly diurnal. At Raccoon Pass, the tidal range varies from a low of 0.5 ft during equatorial tidal conditions to a high of 3.2 ft during tropic tides.

Sea-level Rise and Subsidence

Eustatic Sea-level Change

Eustatic sea-level change is the global change of the oceanic water level. According to IPCC (2007), the global mean sea-level (MSL) rose at an average rate of about 1.7 mm/yr during the twentieth century. Recent climate research has documented global warming during the twentieth century, and has predicted either continued or accelerated global warming for the twenty-first century and possibly beyond (IPCC, 2007). Based on USACE's projections of future changes in MSL (USACE, 2009b) designated as low/historic, intermediate and high, the corresponding eustatic sea-level changes between 2006 and 2062 are estimated at 95 mm, 222 mm, and 635 mm, respectively.

Relative Sea-level Change

Relative sea-level change is the term applied to the difference between the change in eustatic sea-level and the change in land elevation. The combination of subsidence (land sinking) and eustatic sea-level rise are likely to cause the landward movement of marine conditions into estuaries, coastal wetlands, and fringing uplands (Day and Templet, 1989; Reid and Trexler, 1992).

According to NOAA (http://tidesandcurrents.noaa.gov), the relative MSL trend at Grand Isle, LA is 9.24 mm/yr with a 95% confidence interval of +/- 0.59 mm/yr. Using the USACE (2009b) projections of future changes in MSL, the estimated sea-level changes in the LCA TBBSR Study Area between 2006 and 2062 are 0.517 m, 0.644 m, and 1.058 m, for the low/historic, intermediate and high rates, respectively. These are the highest rates along the contiguous United States and helps to explain coastal evolution in Louisiana. Subsidence and rising sea-level are also largely responsible for shoreline erosion and the transgressive nature of most of the barrier islands in Louisiana (USACE, 2004c).

Tidal Inlets and Tidal Prism Dynamics

The following tidal inlets and tidal prism dynamics information is incorporated by reference from Appendix D – Louisiana Gulf Shoreline Restoration Report – of the Louisiana Coastal Area (LCA) Ecosystem Restoration Study (per NEPA Section 1502.21; USACE, 2004c).

Barrier island development along the Louisiana coast is a product of river avulsion and the subsequent reworking of distributary headlands (Penland et al., 1988). The size and number of tidal inlets along the barrier coast are controlled, in part, by the volume of water (tidal prism) moving into and out of back-barrier bays. The historic evolution of these tidal inlets is a product of changes in extent and configuration of the back-barrier bays.

Generally, tidal exchange between back-barrier bays and the GOM has increased along the Deltaic Plain since at least the 1880's due to widespread conversion of wetlands and salt marsh to open water areas. For example, in the mid-1800's the Isles Dernieres were backed by Lake Pelto. At that time, the lake was surrounded by a near uninterrupted expanse of marshland. Over the subsequent hundred years to the mid-1900s, land subsidence, wave erosion of the marsh shoreline, and dredging activity transformed the lake into a large continuous sound having an open connection to Caillou Bay to the west and Terrebonne Bay to the east. The historic changes to the Isles Dernieres are symptomatic of the wetland loss and barrier evolution along the entire Deltaic Coastal Plain.

Tidal prism dynamics and the pattern of tidal exchange dictate the occurrence and geometry of tidal inlets along the various barrier chains. Tidal inlets along the Timbalier Islands have highly variable geometries due to the segmented nature of the barrier system. Much of the tidal exchange between the back-barriers of Caillou Bay, Terrebonne Bay and Timbalier Bay and that of the GOM occurs through broad shallow channels where the transgressive barriers have undergone extensive erosion. However, there are several relatively deep passes 20 to 33-ft deep that are maintained by strong tidal currents on the order of 3.3 ft/s.

Estuarine Circulation

The following estuarine circulation information is incorporated by reference from Appendix D – Louisiana Gulf Shoreline Restoration Report – of the Louisiana Coastal Area (LCA) Ecosystem Restoration Study (per NEPA Section 1502.21; USACE, 2004c).

Circulation of coastal waters depends on driving forces such as tides, wind, and atmospheric pressure. Along the complex Louisiana coast, circulation mechanisms go beyond these driving forces to include high rainfall; the large volume of fresh water introduced by the Mississippi and Atchafalaya Rivers; currents induced by density differences and mixing processes of these two masses of water; local shoreline and bathymetric features such as the Mississippi River mouth, barrier islands, marshes, inlets, bays, and so forth.

Tidal currents in Louisiana are relatively small, due to the small tidal amplitude. In the absence of wind, density effects and barometric pressure gradients, these currents reach magnitudes of approximately 0.3 to 0.5 ft/s. Estimates and observations suggest that tidal currents are stronger at the surface of the water column and decrease with increasing depth. This occurrence is primarily due to the encounter of denser and heavier salty gulf waters in deeper regions, which are less likely to respond to small tide variations. Although small in magnitude in open coastal waters, tidal currents can reach velocities of approximately 1.7 ft/s at estuary and barrier island inlets, depending on the inlet dimensions. The amount of circulation attributed to rising and falling tides or tidal induced circulation is measured as a function of the spatial and temporal variability of tides along the Louisiana coast. There is a seven-hour lag before high water from the east coastal zone reaches the west coastal zone, with typical tidal ranges between 1 to 2 ft depending on the time of month and year.

Perhaps more critical than tides, in terms of circulation and mixing, are wind and barometric pressure. Wind can induce circulation in the form of set-up and set-down, seiche, and wind-waves. Similarly, the presence of front-like weather during the winter and storms during hurricane season enhances these processes by producing dynamic wind conditions. The speed and direction of these winds shift abruptly, creating strong gusts. Changing wind speed and direction cause the generation and transformation of waves along the Louisiana coast. Wind and barometric pressure induced circulation is critical and dominant in back bays, enclosed bays, lakes, marshes, and sub-tidal areas. These processes are characterized by extreme water level fluctuations, and are responsible for a significant amount of the erosion taking place along the Louisiana coast.

Another important process in Louisiana is the freshwater exchange and mixing attributed to the Mississippi and Atchafalaya Rivers, and the hundreds of streams and bayous along the coast. The two rivers combined account for a mean flow of approximately 700,000 cfs, with seasonal variations of up to 280,000 cfs. The low density freshwater meets and mixes with the higher density Gulf waters. In the process, the density difference between the two water masses causes density currents. Typically the surface water column is fresh or brackish depending on the strength of the discharge, and the bottom water column is salty. The velocity of the density currents varies in magnitude and is a function of the density difference, discharge velocity, and available head difference. Although relatively small for the most part, these currents can propagate several miles upstream or downstream given the presence of favorable conditions. Periodic intrusion of saltwater can be detrimental to critical habitat in the bays and marshes. Episodic exposure to highly saline water leads to marsh deterioration and systematic land erosion. Salt water intrusion in the Mississippi River has been observed to travel more than 50 miles upstream during low flow. Similarly, during periods of low rainfall and hence low fresh water discharge, salt-water wedges slowly propagate onshore for several miles through inlets and bays.

4.2.2.2 Sedimentation and Erosion

4.2.2.2.1 Historic Conditions

Sediment quality is defined as the suitability of the habitat for supporting designated uses, including, but not limited to, benthic fauna and emergent wetland plants. Storm events, flowing water, and other factors can potentially re-mobilize sediments. Aquatic sediments are essential in maintaining the structure (assemblage of organisms) and function (processes) of aquatic ecosystem. Sediment quality is important due to the role that sediments play in supporting community productivity. The productivity of green plants, algae, and bacteria build the foundation of food webs upon which higher aquatic organisms depend. Sediments provide essential habitats for epibenthic (live on sediments) and infaunal (live in sediments) invertebrates and demersal fish, which represent important food sources for amphibians, reptiles, fish, birds, and mammals. In addition, many fish and amphibian species utilize sediments at stages in their life cycles for the purposes of spawning, incubation, refuge, and over-wintering (LDEQ, 2005).

As described above, the Deltaic Cycle has resulted in the creation of barrier islands, followed by their gradual degradation as the river shifted course, the sediment supply diminished, and a new delta lobe formed. There are several drivers for the gradual degradation: loss of sediment, subsidence, and sea level rise are all insidious but persistent. The three more obvious drivers are tropical storms and hurricanes, discussed above, and longshore and cross-shore sediment transport, described below. Longshore transport is facilitated by the passage of seasonal storm fronts as well as tidal flow, which deposits sediment in ebb- and flood-tide shoals. Cross-shore sediment transport is facilitated by tropical storms and hurricanes, which drive the Gulf across the islands, carrying sediment over and beyond the dune system, or washing it off the dune and beach, to be deposited in the nearshore. Rosati and Stone (2009) considered overwash and breach formation (extreme examples of cross-shore transport) to be the main drivers of morphological change along the coastline from the Chandeleur Islands to the Isles Dernieres.

4.2.2.2.2 Existing Conditions

Longshore Sediment Transport

The following longshore sediment transport information is incorporated by reference from Appendix D – Louisiana Gulf Shoreline Restoration Report – of the Louisiana Coastal Area (LCA) Ecosystem Restoration Study (per NEPA Section 1502.21; USACE, 2004c).

Longshore sediment transport is the movement of sediment parallel to the shore. This process is a result of breaking and shoaling waves suspending sand from the bottom and the displacement of the sediment down-drift by the longshore current. The magnitude of the longshore current intensifies with increasing wave height and breaker angle. In addition to these wave parameters, the rate of transport is a function of beach or barrier orientation, offshore shelf slope, and local depth. In coastal Louisiana, direct measurements of longshore transport are limited. The rates of transport are typically based on historical studies of shoreline erosional and depositional trends, sedimentation patterns in the vicinity of coastal structures, and on numerical wave modeling. Overall net longshore sediment transport along the Isle Dernieres Reach is directed westward at an approximate rate of 45,000 cy per year (cy/yr) and overall net longshore sediment transport along the Timbalier Reach is directed westward at an approximate rate of 15,000 cy/yr (Table 4-5).

Table 4-5. Longshore Sediment Transport Estimates for the Isle Dernieres and Timbalier Islands Reaches (Georgiou et al., 2005)

Geographic Location	Coverage		Rate (cy/yr)	Direction
	From:	To:		
Isle Dernieres reach	East Island	Raccoon Island	43,000	Westward
Timbalier Island reach	Raccoon Pass	Cat Island Pass	14,000	Westward

Isles Dernieres Reach

Sediment transport along the Isles Dernieres is complex given its fragmented nature (Georgiou *et al.*, 2005). Overall, sediment moves in a westerly direction along the Isles Dernieres reach, although local bidirectional transport occurs on Trinity and Whiskey Islands. Sediment movement around Whiskey Pass is largely nonexistent. Waves propagating through the pass break along the marsh shoreline in Lake Pelto (Stone and Zhang, 2001). This process indicates that sand is transported predominantly onshore through the pass, thereby minimizing sediment bypassing that down drift Whiskey Island. Although net transport rates are variable, net westward transport of approximately 78,000 cy/yr has been derived numerically (Stone and Zhang, 2001).

Timbalier Reach

According to Georgiou et al. (2005), net sediment movement along the Timbalier Islands is to the west, and the rate increases from east to west. Sub-scale transport trends are evident on both islands. However, the sand transport system along the island has been greatly diminished due to the extent of coastal structures in the area. The potential for transferring sand from the Caminada Moreau headland to East Timbalier Island is minimal, given the large width of Raccoon Pass and the net landward transport of sand to its flood tidal delta (Georgiou et al., 2005). Kulp et al. (2002) have documented extensive growth of this flood tidal delta suggests that little sand bypasses the inlet. Rather, the sand is worked onshore into Timbalier Bay. Bypassing of sand across Little Pass Timbalier is also minimal. Waves propagate through this inlet prior to breaking inside Timbalier Bay. Further, the jetties at Belle Pass on the western end of the Caminada Headland interrupt the natural flow of sediment, thus reducing the volume transported drown drift (CEC and SJB, 2008).

Similarly, net transport is westward along Timbalier Island with a net increase in rate along the eastern flank of the barrier island to approximately 65,000 cy/yr (Georgiou et al., 2005). Conversely, the rate decreases to the western end of the island. This pattern suggests that sand eroded from the eastern flank is transported to the west where it is deposited along the west flank of the barrier and in Cat Island Pass (Georgiou et al., 2005).

Cross-Shore Sediment Transport

The following cross-shore sediment transport information is incorporated by reference from Appendix D – Louisiana Gulf Shoreline Restoration Report – of the Louisiana Coastal Area (LCA) Ecosystem Restoration Study (per NEPA Section 1502.21; USACE, 2004c).

Cross-shore sediment transport is the movement of sediment in a direction perpendicular to the shoreline. Rates of cross-shore sediment transport are difficult to quantify by direct measurements. As a result, little is known about the dynamics of this process. Cross-shore movement of sediment includes the sand that is eroded from the beach and transported offshore during storms, as well as the sand moved onshore by the process of overwash or during post- storm recovery by fair-weather waves. At the same time, storm waves breaking over low barriers wash sand into back-barrier marshes. This process provides a mechanism for the barrier islands to migrate landward and to reestablish sand platforms that are colonized by marsh vegetation.

4.2.2.3 Water Use and Supply

4.2.2.3.1 Historic Conditions

There were no historic sources of fresh water in the Study Area. Historic water use was limited to personal consumption. Water was either transported to the Study Area or obtained by capturing rain water onsite with cisterns.

4.2.2.3.2 Existing Conditions

There are no onsite sources of fresh water in the Study Area. Supplies of potable water are either transported to the Study Area or obtained by capturing rain water onsite with cisterns.

4.2.2.4 Groundwater

4.2.2.4.1 Historic Conditions

Due to the saline environment, groundwater resources have not historically been utilized in the Study Area.

4.2.2.4.2 Existing Conditions

Due to the saline environment, groundwater resources are not utilized in the Study Area.

4.2.3 Water Quality and Salinity

4.2.3.1 Water Quality

This resource is institutionally significant because of the National Environmental Policy Act of 1969; the Clean Water Act; the Coastal Zone Management Act; and the Estuary Protection Act. This resource is technically significant because the water quality supports most physical, chemical, geological, and biological processes throughout the entire estuarine system. This resource is publicly significant because the public demands clean water and healthy wildlife and fisher species for recreational and commercial use.

4.2.3.1.1 Historic Conditions

Historic and current water quality issues for rivers and streams in coastal Louisiana include the transport of nutrients, pesticides, synthetic organic compounds, trace elements, suspended sediment, and bacteria. The Louisiana Department of Health and Hospitals coordinates with the LDEQ, the LDWF, and the Louisiana Department of Agriculture and Forestry to issue water body advisories aimed at protecting the public's health.

The LDEQ assesses four categories for water use under the Louisiana Environmental Regulatory Code (LAC Title 33, Chapter 11) that would apply to the Study Area. Primary Contact Recreation includes activities such as swimming, water skiing, tubing, snorkeling, skin diving, and other activities that involve prolonged body contact with water and probable ingestion. Secondary Contact Recreation includes fishing, wading, and recreational boating, and other activities that involve only incidental or accidental body contact and minimal probability of ingesting water. Fish and Wildlife Propagation includes the use of water by aquatic biota for aquatic habitat, food, resting reproduction, and cover, including indigenous fishes and invertebrates, reptiles, amphibians, and other aquatic biota consumed by humans. Oyster Propagation includes the use of water to maintain biological systems that support economically important species of oysters, clams, mussels, and other mollusks consumed by humans so that their productivity is preserved and the health of human consumers of these species is protected. In the Study Area, Oyster Propagation was identified as being impaired in some areas. The USEPA and LDEQ identified low dissolved oxygen levels and high fecal coliform levels as the suspected causes for impairment for Oyster Propagation, but were not able to identify the sources of these problems (LDEQ, 2005).

4.2.3.1.2 Existing Conditions

According to the 2002 Water Quality Management Plan, Water Quality Inventory, Section 305(B) report (LDEQ, 2002), the Terrebonne Basin Coastal Bays and Gulf waters were listed as fully supporting all designated uses except fish and wildlife propagation. The suspected causes of impairment are upstream sources and atmospheric deposition of phosphorus, nitrogen, and mercury. Discharges associated with drilling such as water-based mud and cuttings have been released in the region over the past several decades. All discharges are periodically tested and must meet the National Pollutant Discharge Elimination System (NPDES) limits set by the USEPA (USEPA, 2005a). These limits are necessary since produced-water discharge may have higher salinity levels, organic content and dissolved metals, and lower dissolved oxygen levels than the receiving water.

Hydrocarbons found in the GOM come primarily from natural seeps and anthropogenic shore-based and offshore sources. However, since the islands are significantly removed from the mainland, pollution from shore-based sources is unlikely.

The back-bay estuaries of Isles Dernieres are listed as fully supporting primary contact recreation, secondary contact recreation, and oyster production, but do not fully support fish and wildlife propagation (USACE, 2004b). This system has been listed as impaired for one or more uses, but the cause of impairment is listed as a "non-pollutant" (USDA, 2005). The suspected impairment, turbidity, is caused by the close proximity of the GOM, erosion, and suspended sediments in the longshore currents from Mississippi River discharge. The islands contain no fresh surface water, and due to the distance from any significant source, contain no threat of fecal coliform contamination. Consequently, there are no apparent water quality problems for the Isles Dernieres or Timbalier Islands (USEPA, 2002).

4.2.3.2 Salinity Regimes

This resource is institutionally significant because of the National Environmental Policy Act of 1969, the Coastal Barrier Resources Act, and the Coastal Zone Management Act. This resource is technically significant because of the role that salinity plays in land loss and the survival, distribution, and impacts to plants, wildlife, and fisheries resources. This resource is publicly significant because alteration of salinity regimes can accelerate land loss and adversely impact commercial and recreational fishery opportunities.

4.2.3.2.1 Historic Conditions

The Louisiana Department of Wildlife and Fisheries (LDWF) has measured salinity in Terrebonne Bay as part of its finfish-sampling program consistently since 1981. Based on those data, which were collected at least monthly and often several times per month from March 1981 to May 2000, salinity in the bay ranged from 3.4 parts per thousand (ppt) to 29.3 ppt with a mean salinity of 16.6 ppt (USFWS, 2003). This is consistent with data used by the CWPPRA Wetlands Valuation Assessment for the Timbalier Island Dune and Marsh Creation Project (TE-40), which indicated an annual salinity of 20 ppt for this area (USEPA, 2002).

4.2.3.2.2 Existing Conditions

Barrier islands restrict water exchange with estuaries behind them, provide storm surge protection to wetlands and human infrastructure, and modify currents and salinity within the bay system. According to the Louisiana Gulf Shoreline Restoration Report Louisiana Coastal Area (LCA) 2004 Study, a comprehensive model that can evaluate the spatial and temporal links that barrier islands have with the interior bays and coastal marshes is unavailable. The study showed that the barrier islands influence the hydrodynamics of the mixing zone but the hydraulic conveyance of the embayment and the marsh are probably more important. The more open water and conveyance channels in the marshes, the greater the penetration of tidal energy into the marsh and the farther the mixing zone of fresh and saltwater will move into the marsh. Swenson (2000) found that coastal salinities in the central and eastern portions of coastal Louisiana were inversely proportional to Mississippi River discharge, with a range of 10 to 20 ppt but with a fairly wide distribution.

Barrier islands are critical in maintaining salinity gradients, which in turn is vital for proper functioning of the associated estuarine systems (Knotts, et al., 2006). Without these islands, the estuaries deteriorate and higher salinity Gulf of Mexico waters invade the lower salinity interior wetlands and the estuarine gradient between them would collapse and its productivity would be destroyed (Penland et al., 2003).

4.2.4 Air Quality

4.2.4.1 Historic Conditions

This resource is institutionally significant because of the Clean Air Act of 1963, as amended, and the Louisiana Environmental Quality Act of 1983, as amended. Air quality is technically significant because of the status of regional ambient air quality in relation to the National Ambient Air Quality Standards (NAAQS). Air quality is publicly significant because of the desire for clean air and public health concerns expressed by many citizens.

National air quality standards have been set by the USEPA for six common pollutants (also referred to as "criteria pollutants") including: ozone, particulate matter, carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead. States are required by the Code of Federal Regulations to report to the USEPA annual emissions estimates for point sources (major industrial facilities) emitting greater than, or equal to, 100 tons per year of volatile organic compounds, nitrogen dioxide, sulfur dioxide, particulate matter less than 10 microns in size; 1,000 tons per year of carbon monoxide; or 5 tons per year of lead. Since ozone is not an “emission,” but the result of a photochemical reaction, states are required to report emissions of volatile organic compounds (VOC), which are compounds that lead to the formation of ozone.

4.2.4.2 Existing Conditions

Terrebonne and Lafourche Parishes were both designated as attainment areas for ozone for the 1997 Ground-level ozone standard according to the following EPA website:

(http://www.epa.gov/ozonedesignations/1997standards/regions/region6desig.htm). In a letter to the EPA from the Louisiana Department of Environmental Quality dated March 12, 2009, regarding 2008 Ozone National Ambient Air Quality Standards (NAAQS), the State of Louisiana recommended that Terrebonne Parish be listed as unclassifiable and Lafourche Parish be designated as nonattainment. This information was obtained from the following EPA website: http://www.epa.gov/ozonedesignations/index.htm) (USEPA 2009).

4.2.5 Noise

4.2.5.1 Historic Conditions

Noise is institutionally significant because of the Noise Control Act of 1972 that declares the policy of the United States to promote an environment for all Americans free from noise that jeopardizes their health or welfare; and the Occupational Safety and Health Standards (29 CFR, part 1910) regarding protection against the effects of noise exposure. Noise is technically significant because noise can negatively affect the physiological or psychological well-being of an individual (Kryter, 1994) ranging from annoyance to adverse physiological responses, including permanent or temporary loss of hearing, and other types of disturbance to humans and animals, including disruption of colonial nesting birds. Noise is publicly significant because of the public's concern for the potential annoyance and adverse effects of noise on wildlife and humans.

4.2.5.2 Existing Conditions

Noise is typically associated with human activities and habitations, such as operation of commercial and recreational boats, water vessels, air boats, and other recreational vehicles; operation of machinery and motors; and human residential-related noise (air conditioner, lawn mower, etc.). However, the Study Area includes remote barrier islands and offshore sediment borrow areas. The noise from distant urban areas and offshore oil and gas production facilities surrounding the Study Area has little if any impacts on the area.

In recent years concerns have been raised regarding underwater noise and potential impacts on aquatic organisms. There are a wide variety of noise-generating human activities in the marine environment. Very few studies if any have been conducted near dredge operations for island restoration projects. A brief explanation of dredge techniques, procedures, and average time frame of these types of projects are as follows. Dredging typically last an average of 348 days. A cutterhead dredge is commonly used to remove material from the borrow site in which it is transferred to the island restoration area. The cutterhead is mounted on a ladder that is lowered to the sea bottom and is swung back and forth removing any material in its path. The material is pump to the discharge site in which the island restoration begins to take effect. Noise generated from the dredge will be temporary and last until the amount of borrow material needed is placed in the fill template. Only the area in which the dredge operates will be exposed to the underwater noise.

4.2.6 Vegetation Resources

Coastal vegetation resources are institutionally significant because of the Coastal Barrier Resources Act of 1982; Coastal Zone Management Act of 1972; Emergency Wetlands Resources Act of 1986; Estuary Protection Act of 1968; Fish and Wildlife Conservation Act of 1980; the Fish and Wildlife Coordination Act of 1958, as amended; Migratory Bird Conservation Act; Migratory Bird Treaty Act; Endangered Species Act of 1973 (ESA); Magnuson Fishery Conservation and Management Act 1990; National Environmental Policy Act of 1969; the North American Wetlands Conservation Act; the Water Resources Development Acts of 1976, 1986, 1990, and 1992; and Executive Order 13186 Migratory Bird Habitat Protection. Coastal vegetation resources are technically significant because they are a critical element of the coastal habitats. In addition, coastal vegetation resources serve as the basis of productivity, contribute to ecosystem diversity, provide various habitat types for fish and wildlife, and are an indicator of the health of coastal habitats. Coastal vegetation resources are publicly significant because of the high priority that the public places on their aesthetic, recreational, and commercial value.

4.2.6.1 Riparian Vegetation

4.2.6.1.1 Historic Conditions

Riparian wetland vegetation was not historically present in the Study Area.

4.2.6.1.2 Existing Conditions

Riparian wetland vegetation is not currently present in the Study Area.

4.2.6.2 Wetland Vegetation

4.2.6.2.1 Historic Conditions

Visser and Peterson (1995) identified 12 plant species on transects extending across entire barrier islands across Barataria-Terrebonne estuary. The dominant species included marsh hay cordgrass (*Spartina patens*), saltwort (*Batis maritima*) black-mangrove (*Avicennia germinans*), coastal dropseed (*Sporobolus virginicus*), perennial pickleweeds (*Salicornia bigelovii*) and seaoxeye (*Borrichia frutescens*). The spatial distribution of these species was determined by elevation and exposure to the Gulf of Mexico. The succulent species and vines occupied the lower beach face, wire-grass occupied the highest elevations, and smooth cordgrass and black mangrove dominated the protected bayside flats (Mac et al. 1998).

Louisiana Geological Survey conducted vegetation surveys in 1987 and 1988 on Isles Dernieres and then in 1995 on Timbalier and East Timbalier Islands in their efforts to inventory coastal sand dunes of Louisiana. Data was collected along thirteen transects on the Isles Dernieres and eight transects on Timbalier and East Timbalier Islands.

Common beach and dune species included:, smooth cordgrass (*Spartina alterniflora*), bitter panicgrass (*Panicum amarum*), eastern baccharis (*Baccharis halimifolia*), seaoxeye, coastal dropseed, *Cyperus sp*., Jesuit's bark (*Iva frutescens*), beach morning glory (*Ipomoea stolonifera*), seashore paspalum (*Paspalum vaginatum*), annual seepseed (*Suaeda linearus*), seaside goldenrod (*Solidago sempervirens*), *Sabatia stellaris*, marsh fimbry (*Fimbristylis castaneae*), Olney's bulrush (*Scirpus olneyi*), and shoreline seapurslane (*Sesuvium portulacastrum*) (Ritchie et al. 1989 and Ritchie et al. 1995).

Typical mangrove-saltmarsh species included *Batis maritima*, *Salicornia bigelovii*. *Avicennia germinans*, and *Spartina alterniflora* (Ritchie et al. 1989 and Ritchie et al. 1995).

4.2.6.2.2 Existing Conditions

The vegetation species composition in existence today is similar to that reported by Ritchie et al. 1989 and 1995 and Visser and Peterson (1995).

Barrier shorelines and associated back marsh areas are dynamic areas with considerable spatial and temporal variation in plant species distribution. The Study Area is subjected to varying degrees of natural and human disturbance. Vegetation is one of the most important factors in trapping and retaining sediments in the barrier shoreline system. The zones or communities of barrier island vegetation and the extent of their diversity are related to elevation, degree of exposure to salt spray, and storm events that cause overwash. These zones often intergrade with each other: beach pioneer zone → frontier zone → dune → barrier grasslands → salt flats → salt marsh → intertidal mud flats (after Ritchie et al. 1990 and 1995). The species found in the Terrebonne Basin (Table 4-6) are similar to those recoded in the adjacent Barataria Basin by Ritchie et al. (1990); and Ritchie et al. (1995).

Vegetation contributes to the stability of barrier islands. Plant colonies trap and retain suspended sediment (those essential for platform accretion and dune formation), and protect those newly deposited material from erosion. Vegetation also contributes to soil structure, nutrients, and trophic level food supply through their decomposition, and subsequent accumulation of organic matter (detrital material). In addition to the structural and nourishment benefits, vegetation also provides habitat function and serves as an indirect indicator of wildlife and fisheries species vigor and condition (USDA, 2005). Similarly, the types and productivity of vegetative communities are controlled by the factors that influence coastal land loss, and their ability to adapt to those conditions. The loss of wetlands has and continues to impact all vegetative community types, from the barrier islands, headlands, and salt marshes at the coastal shore, to the interior fresh marshes, swamps and bottomland forests (USACE, 2004a).

Marsh vegetation within coastal Louisiana includes those associated with fresh, brackish and saline conditions. Salt marsh communities (those that are common and fundamental to barrier islands) are characterized by some degree of tidal inundation, saline substrates, waterlogged soils, and salt-tolerant vegetation. These communities develop in the lee of the barrier islands, providing lateral support to the beach, and essential nursery grounds for finfish and shellfish (USEPA, 1997a).

Rare, Unique, and Imperiled Vegetative Communities

The Louisiana Natural Heritage Program describes imperiled vegetative communities occurring in the Study Area including: coastal mangrove thicket, coastal dune grassland, and coastal dune shrub thicket. These communities are nestled within the broader vegetative habitats and are important in that they contribute to the extensive diversity of the coastal ecosystem, enhance its productivity, and are essential to the stability of the bionetwork.

Table 4-6. Vegetation of Study Area [source: based on site visits and after Ritchie et al. (1990); and Ritchie et al. (1995)]

Plant Species	Beach Pioneer Area	Frontier Zone	Dune	Barrier Grassland	Salt Flats	Salt Marsh	Intertidal Mud Flats	Spoil Banks
Agalinis maritima (seaside gerardia)				X				
Agalinis purpurea (purple gerardia)				X				
Amaranthus greggii		X						
Atriplex cristata (sea-beach orach)	X							
Avicennia germinans (black mangrove)								
Baccharis halimifolia (groundsel bush)				X		X		X
Batis maritima (saltwort)						X		
Borrichia frutescens (sea ox-eye)				X	X	X		
Bostrichia spps						X		
Cakile geniculata (sea rocket)	X	X	X					
Chenopodium album (pigweed, lamb's-quarters)	X	X	X					
Cissus trifoliata (marine-vine)								X
Colocasia esculentum (elephant ear)	X							
Croton punctatus (beach tea)	X	X	X	X				
Cuscuta gronovii (common dodder)						X		
Cuscuta indecora (pretty dodder)						X		
Cynanchum angustifolium (milkweed vine)				X				
Cynodon dactylon (Bermuda grass)		X	X					
Cyperus spp.	X	X	X	X	X			
Distichlis spicata (salt grass)	X	X		X		X		X
Ectocarpus spps						X		
Enteromorpha spps						X		
Eustoma exaltatum (seaside gentian)				X	X			
Fimbristylis castanea (sand rush)				X	X			
Heliotropium curassavicum (seaside heliotrope)	X							X
Heterotheca subaxillaris (camphor weed)			X					
Hydrocotyle bonariensis (sand pennywort)		X	X	X				
Ipomoea pes-caprae (goatsfoot morning glory)		X						
Ipomoea imperati (beach morning glory)		X	X	X				
Iva frutescens (marsh elder)			X	X		X		X
Juncus roemerianus (black needle rush)						X		
Lantana camara (lantana)								X
Limonium carolinianum (sea lavender)				X	X			
Lonicera japonica (Japanese honeysuckle)								X
Morella cerifera (*Myrica cerifera*, wax myrtle)				X				X
Panicum amarum (bitter panicum)		X	X	X				
Panicum repens (dog-tooth grass)	X	X	X	X				
Paspalum vaginatum (seashore paspalum)				X				
Phragmites australis (roseau cane)				X				
Phragmites communis (roseau cane)		X						
Phyla nodiflora (frogfruit)				X				
Polysiphonia spps						X		
Portulaca oleracea (common purslane)	X							
hynchospora colorata (*Dichromena colorata*, white-topped sedge)				X				
Sabatia stellaris (common marsh pink)				X	X			
Salicornia bigelovii (Bigelow glasswort)					X	X		
Salicornia virginica (creeping glasswort)					X			
Schizachyrium littorale (maritime bluestem)			X	X				
choenoplectus americanus (*Scirpus olneyi*, (three-cornered grass)				X				
Uniola paniculata (sea oats)			X					
Sesbania drummondii (rattlebox)		X	X	X				
Sesuvium portulacastrum (sea purslane)	X	X	X		X			
Simphyotrichum tenuifolium (*Aster tenuifolius*, saltmarsh aster)				X				
Solidago sempervirens (seaside goldenrod)		X	X	X		X		X
Spartina alterniflora (smooth cordgrass, oyster grass)		X				X		X
Spartina patens (marsh-hay cordgrass)	X	X	X	X		X		X
Sporobolus virginicus (coastal dropseed)	X	X	X	X	X			
Strophostyles helvola (wild bean)			X	X				

4.2.6.3 Upland Vegetation

4.2.6.3.1 Historic Conditions

Upland vegetation was not historically present in the Study Area.

4.2.6.3.2 Existing Conditions

Upland vegetation is not currently present in the Study Area.

4.2.6.4 Submerged Aquatic Vegetation

4.2.6.4.1 Historic Conditions

Based on a review of the U.S. Fish and Wildlife Service National Wetland Inventory Map data, which includes a historic wetlands map information layer, there is no indication that submerged aquatic vegetation historically existed in the Study Area (U.S. Fish and Wildlife Service 2009).

4.2.6.4.2 Existing Conditions

Based on a review of the U.S. Fish and Wildlife Service National Wetland Inventory Map data and site visits, no submerged aquatic vegetation was observed and/or known to exist in the Study Area (U.S. Fish and Wildlife Service 2009).

4.2.6.5 Invasive Species – Vegetation

4.2.6.5.1 Historic Conditions

Historical information regarding the presence of invasive species in the Study Area has not been found.

4.2.6.5.2 Existing Conditions

Although some potentially invasive species [Chinese tallow (*Triadica sebifera*) and cogongrass (*Imperata cylindrica*)] are actively infesting Gulf coast wetlands and forests, no problems caused by encroachment of these species have been reported on Louisiana's barrier islands (personal communications C. Steyer, NRCS; K. Bahlinger, LDNR; M. Hester, LSUNO; M. Materne, LSU Agcenter; I. Mendelssohn, LSU; C. Reid, LDWF; J. Visser, LSU). This is likely due to the extreme environmental conditions, such as higher salinities, shifting substrates, and frequent storm disturbance that severely limit suitability of the habitat for colonization.

4.2.7 Wildlife and Habitat

4.2.7.1 Historic Conditions

This resource is institutionally significant because of the National Environmental Policy Act of 1969; the Coastal Zone Management Act; Estuary Protection Act; the

Fish and Wildlife Coordination Act of 1958, as amended; the Migratory Bird Conservation Act of 1929, as amended; the Migratory Bird Treaty Act of 1918; the Endangered Species Act of 1973 (ESA), as amended; the Fish and Wildlife Conservation Act of 1980; the North American Wetlands Conservation Act; Executive Order 13186 Migratory Bird Habitat Protection; Migratory Bird Conservation Act; and the Marine Mammal Protection Act. Wildlife resources are technically significant because they are a critical element of the coastal barrier ecosystem, they are an important indicator of the health of coastal habitats, and many wildlife species are important recreational and commercial resources. Wildlife resources are publicly significant because of the high priority that the public places on their aesthetic, recreational, and commercial value.

Wildlife distributions in barrier systems are influenced by landforms, climate, salinity, tides, vegetation, other animals, and human activities (Day et al. 1989). Wildlife, their general habits and habitat requirements potentially occurring in the Study Area are described in the following: Conner and Day (1987), Abernethy (1987), Condrey *et al*. (1995), Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority (1999) (hereinafter referred to as the Coast 2050 Report (1999).

4.2.7.2 Existing Conditions

4.2.7.2.1 Amphibians and Reptiles

Little if any information exists regarding the population status of amphibians and reptiles in the Study Area. Condrey et al. (1995) indicates that virtually nothing is known about the populations of seven species of salamanders, 13 species of frogs and toads reportedly occurring in the Barataria-Terrebonne National Estuary. With the exception of American alligator (*Alligator mississippiensis*) harvest data, there is a general lack of data on the status and trends of most of the reptiles' worldwide (Gibbons et al. 1999) as well as those species that may inhabit the Study Area. Generally, direct harvest and loss and degradation of habitat have resulted in the depletion of all the Terrebonne Basin's commercially important reptiles (Condrey et al.1995). The herpetofauna typically found in the Gulf salt marsh environments are the Gulf salt marsh snake (*Nerodia clarkii clarkia*), the Gulf coast toad (*Bufo valliceps*), and the diamondback terrapin (*Malaclemys terrapin)* (Abernethy (1987). Condrey et al. (1995) reports that coastal erosion and barrier island retreat directly threatens the diamond-backed terrapin (*Malaclemys terrapin*).

4.2.7.2.2 Mammals

Other than fur harvest records, little is known about the status and trends of mammals throughout the Barataria-Terrebonne Basin (Condrey et al. 1995). The interagency Coast 2050 Report (1999) characterizes the current population status, population trends since 1985, and population projections to 2050 for several furbearers, (including nutria, muskrat, mink, river otter, and raccoon) and three game mammals (rabbit, squirrel, and deer) for various habitat types throughout the Study Area. Deer and squirrel have not been historically present or are no longer present throughout the entire Study Area. Rabbit populations have been steady since 1985, but only in the Caminada Headland area. Furbearer population trends since 1985 are reportedly decreasing throughout the entire Study Area.

4.2.7.2.3 Avifauana

The Study Area is located within the Mississippi River migration flyway (Bellrose, 1980) that is a major bird migration corridor within North America. The Study Area is an important staging area for migrating neotropical passerines. Abernethy (1987) reports 411 species of birds inhabit the Barataria-Terrebonne estuary. The decline in populations of neotropical passerine migrants is a serious conservation problem; one that may be linked to the availability of suitable en route habitat where energy reserves critical to successful migration can be replenished rapidly and safely (Moore et al. 1990). The Study Area is also important to shorebirds and waterfowl, as well as providing important wintering and breeding habitat for many different species of seabirds, shorebirds, wading birds, waterfowl, raptors, and songbirds (Lowery, 1974; Helmers, 1992; Chabreck et al., 1989; Martin and Lester, 1991; Condrey et al., 1995; BTNEP, 1996; Coast 2050 Report, 1999). Martin and Lester (1991) and Visser and Peterson (1994) provide information and maps regarding colonial nesting seabirds and wading bird populations in the Study Area. Condrey et al. (1995) cites 353 species of birds occurring throughout the Barataria-Terrebonne estuary. Condrey et al. (1995) summarize the historical trends and causes for change, habitat requirements, and major factors affecting selected groups of avifauna species occurring throughout the Barataria-Terrebonne estuary system.

According to a survey done by Louisiana Department of Wildlife and Fisheries in 2008, approximately 44,771 nesting pairs of wading birds and seabirds were observed throughout the Isle Dernieres reach. Louisiana Department of Wildlife and Fisheries completed a Bird Colony Survey in 2006 for Timbalier and Terrebonne Bay areas. Approximately 1,265 wading bird and seabird colonies inhabit along East Timbalier Island and Bayou Lafourche (Personal Communication Mike Carlos LDWF, 2009). Louisiana coastal wetlands provide essential stopover habitat for neotropical migratory birds on their annual migration route. Without stopover sites to provide adequate food supply for the quick replenishment of fat reserves, shelter from predators, and water for rehydration, migratory birds may be negatively affected. Continued losses of wintering habitat and a better understanding of waterfowl requirements have led to increased concern and interest in the conservation of breeding, migration, and wintering habitats (USACE, 2004).

4.2.7.2.4 Invasive Wildlife Species

The nutria (*Myocastor coypus*) and the Norway rat (*Rattus norvegicus*) are the primary invasive mammalian species that could occur throughout the Study Area (http://invasive.btnep.org/). However, the nutria is typically found in the freshwater swamps and marshes of the Barataria-Terrebonne estuary system which are located outside of the Study Area (Condrey et al., 1995). The monk parakeet (*Myiopsitta monachus*), Eurasian collared-dove (*Streptopelia decaocto*), English sparrow (*Passer domesticus*), European Starling (*Sturnus vulgaris*), and cattle egret (*Bubulcus ibis*) are all potential invasive avian species that could be found in the Study Area (http://invasive.btnep.org/default.asp?id=51).

4.2.8 Aquatic Resources

4.2.8.1 Plankton

This resource is institutionally significant because of the National Environmental Policy Act of 1969, the Coastal Zone Management Act, and the Estuary Protection Act. This resource is technically significant because plankton provide a major, direct food source for animals in the water column and in the sediments; plankton are responsible for at least 40% of the photosynthesis occurring on the earth; plankton are important for their role in nutrient cycling; plankton productivity is a major source of primary food-energy for most estuarine systems throughout the world; and phytoplankton production is the major source of autochthonous organic matter in most estuarine ecosystems (Day et al., 1989). This resource is publicly significant because plankton form the lowest trophic food level for many larger organisms important to commercial and recreational fishing. In addition, there is a public health concern with noxious plankton blooms (red and brown tides) that produce toxins, and large-scale blooms can lead to hypoxic conditions, which can result in fish kills.

4.2.8.1.1 Historic Conditions

Plankton communities serve an important role in the coastal waters of Louisiana. Phytoplanktons are the primary producers of the water column, and form the base of the estuarine food web. Zooplanktons provide the trophic link between the phytoplankton and the intermediate level consumers such as aquatic invertebrates, larval fish, and smaller forage fish species (Day et al., 1989). Microzooplanktons appear to be important consumers of bacterioplankton, which are typically enumerated by culture and microscopic techniques. Culture techniques are selective and invariably underestimate bacterial densities (Day et al., 1989). "The Cooperative Gulf of Mexico Estuarine Inventory and Study, Louisiana," prepared by the Louisiana Wildlife and Fisheries Commission in 1971 provides a summary of plankton across the coastal estuaries of Louisiana in the late 1960s (Perret et al., 1971). The dominant member of the zooplankton community throughout that study was the copepod *Acartia tonsa*. The greatest concentrations of zooplankton were encountered in Breton Sound. The lowest concentrations were encountered in

Chandeleur Sound and Lake Borgne east of the Mississippi River, Lakes Barre and Raccourci, and Terrebonne and Timbalier Bays. Species diversity was greatest in the Breton Sound and Mississippi River, East Bay, Garden Island Bay, and West Bay areas.

Historically, salinity appears to be the chief controlling factor in the number of species present, while temperature, competition, and predation control the number of individuals present (Day et al., 1989). In addition, the abundance of certain zooplankton may be indicative of good fishing areas. While some zooplanktons are euryhaline, others have distinct salinity preferences (Day et al., 1989). Therefore, introduction of river water into estuarine systems may have dramatic short-term impacts on plankton populations in adjacent coastal waters (Hawes and Perry, 1978).

4.2.8.1.2 Existing Conditions

Plankton is composed of three groups: the bacterioplankton, phytoplankton, and zooplankton (Knox 2001). Plankton communities serve several important roles in the coastal waters of Louisiana. Bacterioplankton are primarily decompsers; phytoplankton are the primary producers of the water column, and form the base of the estuarine food web; zooplankton provide the trophic link between the phytoplankton and the intermediate level consumers such as aquatic invertebrates, larval fish, and smaller forage fish species (Day et al. 1989). Most of the fish and other nektonic species are part of the planktonic community only for the early stages of their life cycles (Thompson and Forman 1987).

Phytoplanktons are single-cell algae that drift with the motion of water. The dominant groups are diatoms and dinoflagellates; other important groups include cryptophytes, chlorophytes (green algae), and chrysophytes (blue-green algae). Phytoplankton productivity is a major source of primary food-energy for most estuarine ecosystems throughout the world (Day et al. 1989). Species composition of a given phytoplankton community is a function of various environmental factors including salinity, turbidity, nutrients, turbulence, and depth (Day et al. 1989).

Zooplankton are faunal components of the plankton, including small crustaceans such as copepods, ostracods, euphausiids, and amphipods; the jellyfishes and siphonophores; worms, mollusks such as pteropods and heteropods; and the egg and larval stages of the majority of benthic and nektonic animals (Rounsefell 1975). Zooplankton are weakly swimming animals comprised of two broad categories: holoplankton, which are planktonic species as adults, and meroplankton, which are organisms that occur in the plankton during early life stages before becoming benthic or nektonic (most common are immature forms of benthic invertebrates). Zooplanktons serve as food for a variety of estuarine consumers, but also are important for their role in nutrient cycling.

Within the nearby Barataria Basin, the zooplankton community is dominated by copepods of the genus Acartia (Gillespie 1971, 1978; Bouchard and Turner 1976; Conner and Day 1987). Perret et al. (1971) indicates the dominant member of the zooplankton community throughout Louisiana was the copepod *Acartia tonsa*. Zoeae (a larval stage in some crustaceans) can make up a large component of the meroplankton. Fish larvae (e.g., *Brevoortia patronus*, *Anchoa mitchilli*, *Menidia beryllina* and *Mugil cephalus*) and fish eggs were found throughout the Barataria Basin (Conner and Day 1987). Zooplankton in Louisiana waters are in some cases dominated by zoeae of the mud crab *Rithropanopeus harrisii*. While some zooplanktons are euryhaline, others have distinct salinity preferences. Historically, salinity appears to be the chief controlling factor in the number of species present, while temperature, competition, and predation control the number of individuals present (Perret et al. 1971). In addition, the abundance of certain zooplankton may be indicative of good fishing areas. Conner and Day (1987) indicate that in most estuaries, zooplankton feed on phytoplankton or ingest detritus or both. Most zooplankters are filter feeders and the suspended detritus particulate material in the waters of Barataria is probably a major food source.

Biological factors such as predation by nekton and ctenophores, duration of the larval stages of meroplankton, and changes in the aquatic environment brought by the zooplankton populations themselves are important biological factors in the regulation of zooplankton densities (Bouchard and Turner 1976; Conner and Day 1987). Bouchard and Turner (1976) found that salinity largely influenced the distribution of zooplankton. Gillespie (1978) found spring zooplankton peaks were related to temperature. Conner and Day (1987) identified the following factors affecting zooplankton populations: tidal flushing, inflow of freshwater carrying organic detritus, river discharge, water depth, tidal changes, turbidity, and dissolved oxygen.

4.2.8.2 Benthic

4.2.8.2.1 Historic Conditions

These resources are institutionally significant because of the NEPA of 1969; the Coastal Zone Management Act; and the Estuary Protection Act. These resources are technically significant because the bottom of an estuary regulates or modifies most physical, chemical, geological, and biological processes throughout the entire estuarine system via what is called a “benthic effect.” Benthic animals are directly or indirectly involved in most physical and chemical processes that occur in estuaries (Day et al., 1989). Benthic resources are publicly significant because members of the epibenthic community (e.g., oysters, mussels, etc.) provide commercial and recreational fisheries as well as creating oyster reef habitats used by many marine and estuarine organisms.

Benthic community structure is not static; it provides a residence for many sessile, burrowing, crawling, and even swimming organisms. The benthic community is a storehouse of organic matter and inorganic nutrients, as well as a site for many vital chemical exchanges and physical interactions. Day et al. (1989) describe the functional groups of estuarine benthic organisms. These groups include: macrobenthic (e.g., molluscs, polychaetes, decapods); microbenthic (e.g., protozoa); meiobenthic (e.g., nematodes, harpacticoid copepods, tubillaria), epibenthic; infauna (e.g., most bivalves); interstitial fauna (e.g., beach meiofauna, tardigrades); suspension-feeders (e.g., bryozoans and many bivalves); filter-feeders (e.g., poriferans, tunicates, bivalves); nonselective deposit feeders (e.g., gastropods); selective deposit feeders (e.g., nematodes, sand dollars, fiddler crabs); raporial feeders and predators (e.g., star fish and gastropod drills); and parasites and commensuals (e.g., parasitic flatworms and copepods, pea crabs).

The bottom estuarine substrate or benthic zone regulates or modifies most physical, chemical, geological, and biological processes throughout the entire estuarine system via what is commonly called a "benthic effect" (Day et al., 1989). Within a salt marsh, less than 10% of the above-ground primary production of the salt marsh is grazed by aerial consumers. Most plant biomass dies and decays and its energy is processed through the detrital pathway. The major consumer groups of the benthic habitat include: bacteria and fungi, microalgae, meiofauna, and microfauna (Mitsch and Gosselink 1993).

According to Mitsch and Gosselink (1993), the salt marsh is a major producer of detritus for both the salt marsh system and the adjacent estuary. Mitsch and Gosselink (1993) point out that the detritus material exported from the marsh is more important to the estuary than the phytoplankton-based production in the estuary. Detritus export and the shelter found along marsh edges make salt marshes important nursery areas for many commercially important fish and shellfish. Salt marshes have been shown at times to be both sources and sinks of nutrients, particularly nitrogen.

Baker et al. (1981) sampled the Louisiana Continental Shelf (LCS), including Ship Shoal, to determine the ecological effects of petroleum production platforms in the central Gulf of Mexico. Results indicate that the benthic communities of the Ship Shoal varied from that found throughout the LCS (Table 4-7).

Table 4-7. Percent taxonomic composition of meiofauna, macroinfauna and macroepifauna from the Baker et al. (1981) study

Category and Taxa	Ship Shoal (%)	Louisiana Continental Shelf (%)

Meiofauna		
Formineferia	0.2	55.3
Nematoda	97.0	34.7
Macroinfauna		
Polychaeta	62.6	69.0
Macroepifauna		
Osteichytes	69.3	32.8
Decapoda	30.7	25.7

4.2.8.2.2 Existing Conditions

Baustian (2005) sampled the benthic infauna over a broad area of hypoxia off the central coast of Louisiana. The extent of the sampled area consisted of three zones, the inshore zone, hypoxia zone, and offshore zone. The inshore zone coincides with the LCA TBBSR Study Area. Baustian reports that the infauna were composed mostly of polychaetes, but molluscs, ecninoderms and crustaceans were abundant in most areas. In the inshore areas, the *Paraprionospio pinnata* and *Prionospio pygmaea*, *Mulinia lateralis* and *Tellina versicolor*, *Hemipholis elongate*, and the *Oxyurostylis smithi* were the abundant spionids, mollusks, echinoderms, and crustaceans respectively (Figure 4-10). This assemblage is typical of soft bottom, mesohaline (5 ppt –18 ppt) communities throughout the northern Gulf of Mexico.

Offshore sand shoals (e.g., Ship Shoal) and the nearshore sand bodies represent potential sources for the millions of tons of sand sediment that would be necessary for coastal restoration. With its extensive oil and gas activities, the benthic resources on Ship Shoal have been extensively studied. The following is a summary of the benthic resources on Ship Shoal provided by the MMS (personal communication Barry Drucker, Minerals Management, 2002).

Ship Shoal benthic communities are threatened by two natural environmental perturbations that occur on the Louisiana continental shelf (LCS), anoxic to hypoxic bottom conditions and tropical cyclones. The change from anoxic to hypoxic conditions occurs annually with inconsistent intensities and ranges (Rabalais et al. 1993). On average, one tropical cyclone visits the LCS once every four years, which can vary in intensity (Stone 2000). It takes from one to two years for the benthic communities to recover from either of these types of events (Baker et al. 1981).

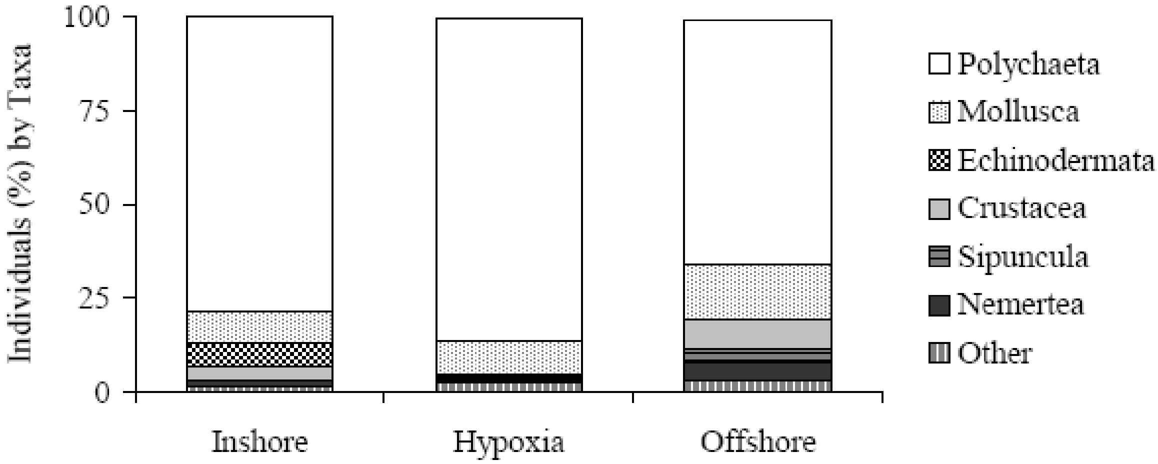

Figure 4-10. Percent of individuals by major taxonomic group for summer samples. (Baustian, 2005)

Results from the Southwest Research Institute study indicated that the prevailing macroepifauna and demersal fish on Ship Shoal are in the taxa Osteichytes (69.3%) and Decapoda (30.7%). Taxa Decapoda, although similar in taxonomic composition to that found on the LCS, was lower in diversity on Ship Shoal. The taxa Osteichytes was found to be particularly higher in taxonomic composition (69.3%) of the total macroepifauna, but lower in diversity when compared to the entire LCS. Shallower water depths such as those found on Ship Shoal were correlated to a larger abundance of taxa Osteichytes and would explain the increased taxonomic composition (Baker et al. 1981). The biomass of demersal fish on Ship Shoal was found to be much higher than those of the LCS on average. The biomass on Ship Shoal was recorded at 151.8 lbs/hr (68.7 kg/hr) in comparison to an average of 43.3 pounds/hr (19.6 kg/hour) throughout the LCS (Baker et al. 1981). These results suggest that Ship Shoal is an extremely productive ground for demersal fish in the context of the LCS.

The diversity, taxonomic composition, and presence of opportunistic species indicate that the fauna residing on Ship Shoal and the LCS are stressed. This slightly depressed state may remain constant because of the periodic perturbations and recovery time needed by benthic communities. Even though the benthic communities of the LCS are stressed, they still resemble the assemblages of similar environments. Results from the Southwest Research Study found that the benthic assemblages on the LCS and Ship Shoal were similar to those found offshore of Texas and the eastern United States despite their depressed state (Baker et al. 1981; Vittor 1987).

In an effort to gain a better understanding of the role of Ship Shoal plays in Louisiana's coastal ecosystem and to address the potential effects of sand mining on the benthic community, Stone et al. (2004) conducted extensive field surveys of the benthic community. Primary producers, meiofauna, and macrobenthos were included in the investigation.

They examined the origin, composition, and spatial and temporal distribution of sediment algae on Ship Shoal. Seasonal variability ranged from < 10 to 50 mg/m^2 in 2005 and from 21 to 53 mg/m^2 in 2006. Sediment algal biomass was highest in the spring and summer and pigment analysis indicated that sedimentary algae were predominantly diatoms across all sample stations and for all seasons. Further analysis of sediment samples revealed that the diatoms were primarily benthic with only a minor fraction being settled phytoplankton. Comparisons of pigments from the sediment and bottom water, suggested a weak exchange of benthic and pelagic algae and the high benthic algal biomass. The report concluded that the high benthic algal biomass strongly suggests that benthic primary producers contribute to the food web on Ship Shoal.

Stone et al. (2004) reported that macrobenthic community at Ship Shoal contains a significant number of macroinvertebrate species not previously reported on the Louisiana continental shelf and that the shoal may serve as a source pool for recruitment of benthic invertebrates to surrounding areas impacted by seasonal hypoxia. They also reported high-biomass and high-diversity assemblage of macroinfauna compared to nearby locations and suggested that it may be a “diversity hotspot” as well as an important hypoxia refuge for macroinfauna sensitive to low dissolved oxygen concentrations reported for the surrounding area. Seasonal data indicated a steady but large decline between spring, summer, and autumn which was likely attributed to predation by high concentrations of blue crabs (*Callinectes saidus*).

4.2.9 Fisheries

Fishery resources are institutionally significant because of the Fish and Wildlife Coordination Act of 1958, as amended; the Endangered Species Act of 1973; the Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended (Magnuson-Stevens Act); the Magnuson-Stevens Act Reauthorization of 2006; the Coastal Zone Management Act; and the Estuary Protection Act. Fishery resources are technically significant because: they are a critical element of many valuable freshwater and marine habitats; they are indicators of the health of various freshwater and marine habitats; and many species are commercially important. Fishery resources are publicly significant because of the high priority placed on their aesthetic, recreational, and commercial value.

4.2.9.1 Historic Conditions

The abundance of coastal wetlands, specifically those that provide habitat and support during vital stages of primary and commercial fish life cycles, have established Louisiana’s estuaries as the most productive in the Nation (USACE, 2004a). Central to this productivity is the Barataria-Terrebonne estuarine complex, which generates more brown and white shrimp than any other zone in the state, and supports approximately 20% of the estuarine-dependent fishery resources of the United States (USEPA, 1997a). The high levels of fish productivity within the Barataria-Terrebonne estuary can be attributed to its current erosional barrier island phase within the deltaic cycle. Plant and fish diversity and productivity are highest during the degradation phase due to significant increases in essential "edge" habitats. However, as the interior and barrier island marshes continue to degrade towards open water and/or shoal dominated systems, biological diversity and productivity decline (USACE, 2004a).

4.2.9.2 Existing Conditions

4.2.9.2.1 Isles Dernieres Reach

The Isles Dernieres and its back-bay estuaries and wetlands provide critical habitat for one of the world's most productive commercial fisheries. The islands provide habitat protection, regulate salinity levels, absorb wave energy, and reduce the tidal prism from the GOM (USEPA, 1997a). Fish assemblages and related habitat on the islands can be placed into three primary groups: (1) open surf zone beach, (2) back island low-energy zones, and (3) intra-island ponds and streams (USEPA, 1997a).

As of 2009, there were three existing oyster leases in the Old Camp Pass area, and two pending applications in the southeast Old Camp Pass area of Trinity Island. There were two additional applications for East Island, one in a back bay near the west end of the island (this application contains no expiration date), and the second was on the recurved spit at the east end (LDWF, 2009).

4.2.9.2.2 Timbalier Reach

Surf zones, ponds, lagoons, creeks, inlets, and back-island marshes are all aquatic habitats located on or near the Timbalier islands (USDC, 1998). These island features are typically used by many different fish species for nursery, foraging, and predator habitat. The characteristic species found near the islands are similar to those found at the Isles Dernieres and include *Micropogonias undulates* (Atlantic croaker), *Pogonias cromis* (black drum), *Callinectes sapidus* (blue crab), *Farfantepenaeus aztecus* (brown shrimp), *Brevoortia patronus* (Gulf menhaden), *Sciaenops ocellatus* (red drum), *Cynoscion arenarius* (sand seatrout), *Cynoscion nebulosus* (spotted seatrout), *Scomberomorus maculatus* (Spanish mackerel), *Paralichthys lethostigma* (southern flounder), *Mugil cephalus* (striped mullet), and *Litopenaeus setiferus* (white shrimp). A U.S. Department of Commerce Environmental Assessment of East Timbalier Island Restoration Project report (USDC, 1998) identified a survey by Williams (1988) that also documented nekton assemblages of adult hardhead catfish, squid, and blue crab communities in deepwater tidal creek and channels within East Timbalier Island. The majority of the nekton species that spawn offshore in the GOM, utilize the Timbalier Bay habitat as larvae or young juveniles, and then return to the GOM as adults. The USDC report also identified several fisheries studies (Zimmerman, 1988; Thompson, 1988; and Williams 1988) that indicate the nekton species composition found near the barrier islands closely match those identified within the mainland marshes (USDC, 1998).

4.2.9.3 Implications

Most finfish and shellfish in the Barataria-Terrebonne estuaries show decreasing population trends, with only the Spanish mackerel populations believed to be significantly increasing (Coast 2050). These declines in population may be linked to the extreme degradation of coastal marsh and reductions in the barrier islands extent. Continued loss of barrier islands would expose large areas of estuary and wetlands, and convert back island bays to gulf waters, negatively impacting coastal infrastructure, fish, oyster, and other biological resources (USEPA, 1997a).

4.2.9.4 Finfish

The Timbalier and Isles Dernieres barrier island wetlands, flats, and subtidal habitat provide unique nursery, foraging, and spawning habitat for numerous marine and estuarine species of commercial and recreational importance (personal communication NMFS, February 11, 2009). Coastal wetlands, such as occur throughout the Study Area, produce nutrients and detritus that contribute to the overall productivity of the estuary aquatic food web (Chapter 19 Coastal Systems in 2005 "Ecosystems and Human Well-Being: Current State and Trends: Findings of the Condition and Trends Working Group (Millennium Ecosystem Assessment Series)"). The Study Area is utilized by distinct groups of fish and crustaceans that exhibit a preference for barrier island habitats over mainland habitats or are dependent on these habitats as transients during portions of their life history for foraging and predator refugia (Williams 1998). Common surf zone species include gulf menhaden (*Brevoortia patronus*), spot (*Leiostomus xanthurus*), striped mullet (*Mugil cephalus*), southern kingfish (*Menticirrhus americanus*), anchovies (*Anchoa spp.),* scaled sardine (*Harengula jaguana*), Florida pompano (*Trachinotus carolinus*), Atlantic bumper (*Chloroscombrus chrysurus*), spotfin mojarra (*Eucinostomus argenteus*), and rough silverside (*Membras martinica*). The surf zone temporarily is used by larval and juvenile life stages of some of these species awaiting transport to back-barrier, bay, or mainland habitats. Barrier island flats typically are used by white mullet (*Mugil curema*), longnose killifish (*Fundulus similis*), darter goby (*Ctenogobius boleosoma*), and inland silversides (*Menidia beryllina*). Marsh edge and interior creeks are used by brown shrimp (*Farfantepenaeus aztecus*), white shrimp (*Litopeneaus setiferus*), Atlantic croaker (*Micropogonias undulatus*), spotted seatrout (*Cynoscion nebulosus*), sheepshead minnow (*Cyprinodon variegatus*), killifish, and sand seatrout (*Cynoscion arenarius*), some of which are constituents of assemblages that use the other island aquatic habitats (Foreman 1968; Zimmerman 1988). Additionally, shallow, back-bay areas are inhabitated by American oysters (*Crassostrea virginica*).

Economically important fish species such as spotted seatrout, red drum (*Sciaenops ocellatus*), black drum (*Pogonias cromis*), and southern flounder (*Paralichthys lethostigma*) use the barrier island habitats (e.g., shorelines and passes) for foraging areas, nursery habitat, and staging areas during spawning or associated migratory aggregations (Saucier and Baltz 1993). Additionally, yearlings of red drum and mangrove snapper (*Lutjanus griseus*) have a high affinity for quiescent intra-island creeks and ponds in the post larval early juvenile stages (Thompson 1988).

The nearest port, at Dulac-Chauvin, Louisiana, reported commercial fisheries landings in 2007 at 23.5 million pounds with a dockside value of 35.5 million dollars (NMFS, 2008). Based in part on its high commercial and ecological productivity, the Terrebonne basin was nominated for participation in the National Estuary Program in 1989 in recognition of its significance for ecological and economic sustainability of estuarine resources (http://www.btnep.org/). Abundant harvested species include brown shrimp, white shrimp, sand seatrout, black drum, southern flounder, blue crab (*Callinectes sapidus*), gulf menhaden, and anchovies (Patillo et al. 1997). Important forage species in the area bays and mainland marshes include many of the species associated with barrier islands (Patillo et al. 1997; Zimmerman 1988). Other species that occur in the Study Area during some portion of their life history include the ecologically important grass shrimp (*Palaemonetes spp*.) (Pattillo et al. 1997). Many other non-game species of finfish and shellfish are important links in the food chain to commercially and recreationally harvested species. Study area wetlands produce nutrients and detritus that contribute to the overall productivity of the Terrebonne estuary aquatic food web.

4.2.9.5 Shrimp

Gulf region landings of shrimp were the nation's largest with 176.6 million pounds and 76% of the national total in 2007. In Louisiana, a total of 44.8 million pounds of brown and 63.4 million pounds of white shrimp were landed in 2007, with a value of $43.3 million and $94.1 million, respectively (NMFS, 2008).

Within the BTES, brown shrimp are consistently the most numerous shellfish landings followed by white shrimp, blue crab, and oyster (Baltz et al. 1993). Black drum, striped or black mullet, blue crab, American oyster, and brown shrimp have shown stable trends since 1985. Only white shrimp have displayed increasing fishery landing trends since 1985. However, the connection between fishery landings and salt marsh habitat loss is not clear (Baltz et al. 1993). One hypothesis is that marsh edge (i.e., perimeter) is the critical habitat for many species and that the nursery function will not decline and result in reduced landings until the quantity of marsh edge begins to decline (USACE, 2009).

The offshore borrow site at Ship Shoal and the nearshore borrow sites support white and brown shrimp and spotted seatrout fisheries. These species are major components of the Ship Shoal ecosystem. White and brown shrimp are opportunistic benthic-feeding omnivores. Spotted seatrout are important predators on white and brown shrimp (USACE, 2009).

4.2.9.6 Blue Crab

About eight species of portunid (swimming) crabs use the coastal and estuarine areas in the Gulf of Mexico. Blue crabs are the only species, however, that is located throughout the Gulf that comprises a substantial fishery. They occur on a variety of bottom types in fresh, estuarine, and shallow offshore waters. Spawning grounds are areas of high salinity such as saline marshes and nearshore waters.

Louisiana is the leading blue crab producer in the U.S., producing 32% of the nation's total in 2007 (NMFS, 2008). Statewide, a total of 44.6 million pounds of blue crab were landed in 2007, with a value of $34.3 million (NMFS, 2008). According to a report by McKenzie et al. on the socioeconomic status and trends of the Barataria-Terrebonne Estuary System (BTES; 1995), from 1979-1992 the BTES accounted for more than 70% of the Statewide totals of commercial crab landings.

A U.S. Department of Commerce environmental assessment of East Timbalier Island Restoration Project report (USDC, 1998) identified a survey by Williams (1988) that also documented blue crab communities in deepwater tidal creek and channels within East Timbalier Island. The NMFS (personal communication NMFS February 21, 2009) indicate that research of Ship Shoal, a potential offshore borrow site, suggests there are more diverse and productive macrofauna on the slopes of the shoal and that the shoal may be spawning habitat for blue crab.

4.2.9.7 Oyster

The American oyster is indigenous to coastal Louisiana, and provides a rich ecological and commercial resource (Figure 4-11). Salinity plays a key role in oyster sustainability. Adult oyster can tolerate salinities from 0 to 42 ppt, but the optimal range is 5-15 ppt. Fresher waters fail to support biological function, and more saline waters promote disease and predation. Oysters grow faster in areas with fluctuating salinities within their normal ranges, compared to constant salinity (Pierce and Conover, 1954). Adult oysters are more prone to impacts from changes in water quality than commercially harvested fishes and crustaceans because they are sessile, and cannot relocate in response to changes in water quality parameters.

The importance of Barataria-Terrebonne estuary oyster productivity and supply parallels that of the nekton species. In 2006, Gulf Crassostrea virginica (eastern oyster) fisheries were estimated to account for nearly 74% of the national total, producing 19 million pounds of meat. The critical oyster habitats (oyster beds) in the Terrebonne Basin barrier island chain are typically located in the ponds and the meandering of bayside marshes (NMFS, 2008).

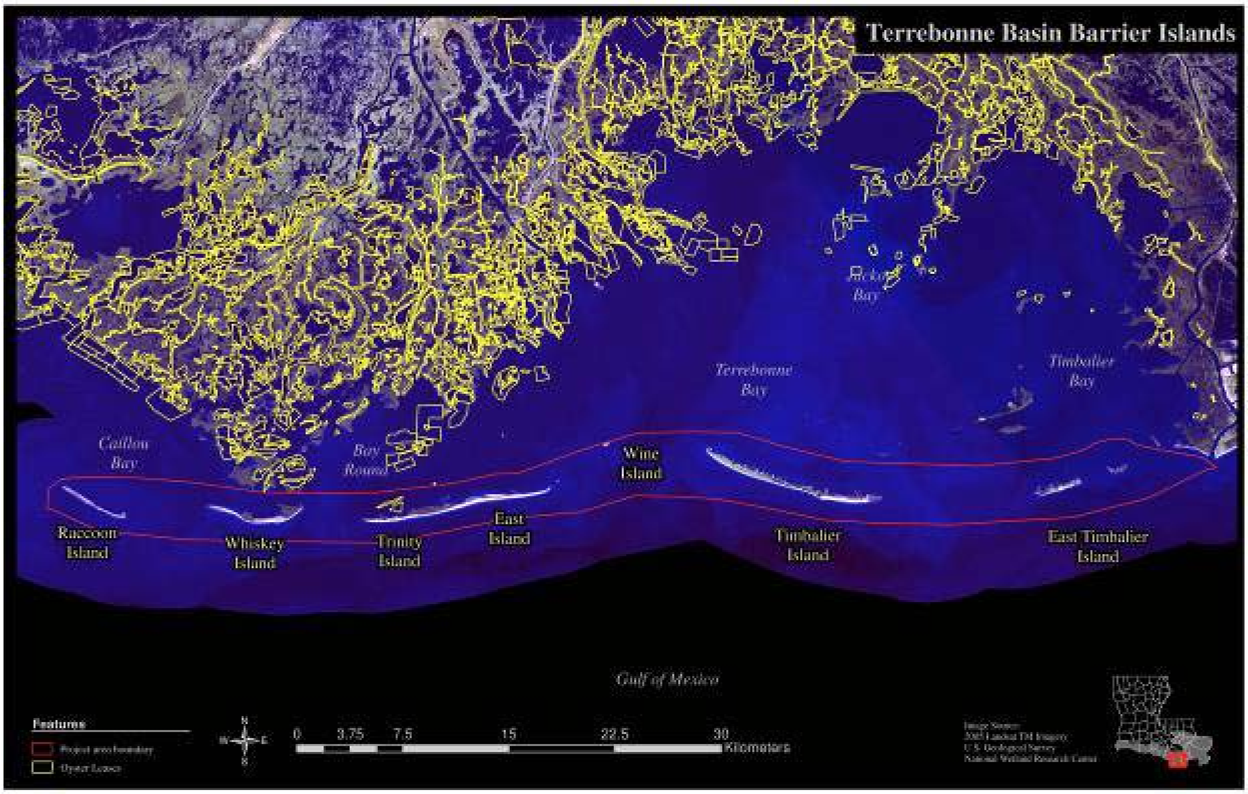

Figure 4-11. Oyster lease map for the Isles Dernieres and Timbalier Reach

4.2.10 Essential Fish Habitat (EFH)

Fishery resources are institutionally significant because of the Fish and Wildlife Coordination Act of 1958, as amended; the Endangered Species Act of 1973; the Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended (Magnuson-Stevens Act); the Coastal Zone Management Act; and the Estuary Protection Act. Fishery resources are technically significant because they are a critical element of many valuable freshwater and marine habitats, they are an indicator of the health of various freshwater and marine habitats, and many fish species are important commercial resources. Fisheries resources are publicly significant because of the high priority that the public places on their esthetic, recreational, and commercial value. Fishery resources in the Study Area include marine and estuarine finfish and shellfish. Table 4-8 provides a summary of the Magnuson-Stevens Fishery Conservation and Management Act designations of essential fish habitat for Coastal Louisiana.

In order to offset declines in fish population and productivity, the Magnuson-Stevens Act of 1978 was established for the protection, conservation, and enhancement of Essential Fish Habitat (EFH). The Magnuson-Stevens Act, which defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity", has been used to establish requirements for fish species in the GOM (Table 4-8) (USACE, 2004b).

Table 4-8. Summary of the Magnuson-Stevens Fishery Conservation and Management Act - Designation of Essential Fish Habitat for Coastal Louisiana* (USACE, 2004b)

Species	Life Stage	EFH
Brown shrimp *Farfantepenaeus aztecus*	eggs larvae postlarvae/ juvenile subadult adult	(Marine system) < 110 m, demersal (Marine system) < 110 m, planktonic (Estuarine system) marsh edge, submerged aquatic vegetation, tidal creeks, inner marsh (Estuarine system) mud bottoms, marsh edge (Marine system) < 110 m, silt sand, and muddy sand
White shrimp *Litopenaeus setiferus*	eggs larvae postlarvae/ juvenile, subadult adult	(Marine system) < 40 m, demersal (Marine system) < 40 m, planktonic (Estuarine system) marsh edge, submerged aquatic vegetation, marsh ponds, inner marsh, oyster reefs (Marine system) < 33 m, silt, soft mud
Red drum *Sciaenops ocellatus*	eggs, larvae postlarvae/ juvenile subadult adult	(Marine system) planktonic (Marine and Estuarine systems) submerged aquatic vegetation, estuarine mud bottoms, marsh/water interface (Estuarine system) mud bottoms, oyster reefs (Marine and Estuarine systems) Gulf of Mexico & estuarine mud bottoms, oyster reefs
Red snapper *Lutijanus campechanus*	larvae, postlarvae/juvenile adult	(Marine system) structure, sand/mud; 17-183 m (Marine system) reefs, rock outcrops, gravel; 7-146 m
Vermilion snapper *Rhomboplites aurorubens*	juvenile	(Marine system) reefs, hard bottom, 20-200 m
Spanish mackerel *Scomberomorus maculatus*	larvae juvenile adult	(Marine system) <50 m isobath (Marine and Estuarine system) offshore, beach, estuarine (Marine system) pelagic
Bluefish *Pomatomus saltatrix*	postlarvae/juvenile adult	(Marine and Estuarine systems) beaches, estuaries, and inlets (Marine and Estuarine systems) Gulf, estuaries, pelagic

*Detailed information on Federally managed fisheries and their EFH is provided in the 1998 generic amendment of the Fishery Management Plans for the Gulf of Mexico prepared by the Gulf of Mexico Fishery Management Council (GMFMC).

4.2.10.1 Historic Conditions

Louisiana's coastal estuaries are the most productive in the Nation. Louisiana has historically been an important contributor to the Nation's domestic fish and shellfish production, and one of the primary contributors to the Nation's food supply for protein. Landings in 2007 for commercial fisheries in coastal Louisiana, estimated at 951 million pounds, were the largest for any state in the contiguous

U.S. and second only to Alaska (NMFS, 2008). These landings represent over 10% of the total landings in the U.S., with a value of approximately $259.6 million.

4.2.10.2 Existing Conditions

By letter dated February 11, 2009, the NMFS indicated that, in addition to being designated as essential fish habitat (EFH), the barrier island aquatic habitats include ponds, lagoon, creeks, tidal channels, sand flats, surf zone, and back barrier marshes. These island habitats and associated near shore water bodies in the Study Area support fish and crustacean assemblages distinctly different from mainland marshes. Examples of economically important marine fishery species in the Study Area include striped mullet (Mugil cephalus), white mullet, Atlantic croaker (Micropogonias undulates), spot, gulf menhaden, Florida pompano, spotted seatrout, sand seatrout, southern flounder, black drum, and blue crab (Williams, 1998 as cited in personal communication NMFS, February 11, 2009). Some of these species serve as prey for other Federally-managed fish species such as mackerels, snappers, groupers, billfishes, and sharks.

Barrier islands provide three primary zones of habitats for shellfish and finfish. These zones of habitats include the surf zone beach; back island low-energy zones that are either sand flats or marsh; and intra-island ponds, lagoons, and meanders (Britton and Morton, 1989). These habitats are characterized by specific physical attributes and can have quite different fish fauna.

The offshore borrow site at Ship Shoal and the nearshore borrow sites support white and brown shrimp and spotted seatrout fisheries. These species are major components of the Ship Shoal ecosystem. White and brown shrimp are opportunistic benthic-feeding omnivores.

Fishery resources in the Study Area include marine and estuarine finfish and shellfish. Aquatic and tidally influenced habitats within the Study Area are designated as EFH for various life stages for shrimp, red drum (Sciaenops ocellatus), reef fish, and stone crab (Table 4-9) managed by the Gulf of Mexico Fishery Management Council (GMFMC). In addition, the waterbodies and wetlands in the Study Area provide nursery and foraging habitats supportive of a variety of economically important fishery species, such as striped mullet, Atlantic croaker, Gulf menhaden, spotted and sand seatrout, southern flounder, black drum, and blue crab. Some of these species serve as prey for other fish species managed under the Magnuson-Stevens Act by the GMFMC.

Table 4-9. Essential Fish Habitat (EFH) for Various Life Stages for Shrimp, Red Drum, Reef Fish, and Stone Crab (source: personal communication NMFS February 21, 2009)

Species	Life Stage	System	EFH
Brown Shrimp	Larvae	Marine	<82 m depth; planktonic, sand/shell/soft bottom, SAV, emergent marsh, oyster reef
	Juvenile	Estuarine	<18 m; SAV, sand/shell/soft bottom, SAV, emergent marsh, oyster reef
White Shrimp	Juvenile	Estuarine	<30 m; SAV, soft bottom, emergent marsh
Pink Shrimp	Juvenile	Estuarine	<65 m; sand/shell substrate
Gulf Stone Crab	Eggs	Estuarine/Marine	<18 m; sand/shell/soft bottom
	Larvae/ Postlarvae	Estuarine/Marine	18 m; planktonic/oyster reefs, soft bottom
	Juvenile	Estuarine	<18 m; sand/shell/soft bottom, oyster reef
Red Drum	Larvae/ Postlarvae	Estuarine	All estuaries planktonic, SAV, sand/shell/soft bottom/ emergent marsh
	Juvenile	Estuarine/Marine	Gulf of Mexico <5 m west from Mobile Bay; all estuaries SAV, sand/shell/soft/hard bottom, emergent marsh
	Adults	Marine/Estuarine	Gulf of Mexico 1-46 m west from Mobile Bay; all estuaries SAV, pelagic, sand/shell/soft/hard bottom, emergent marsh
Lane Snapper	Larvae	Estuarine/Marine	4-132 m; reefs, SAV
	Juvenile	Estuarine/Marine	<20 m; SAV, mangrove, reefs, sand/shell/soft bottom
Dog Snapper	Juvenile	Estuarine/Marine	SAV, mangrove, emergent marsh

4.2.11 Threatened and Endangered Species

This resource is institutionally significant because of the Endangered Species Act of 1973, as amended, and the Marine Mammal Protection Act of 1972. Endangered (E) and threatened (T) species are technically significant because the status of such species provides an indication of the overall health of an ecosystem. These species are publicly significant because of the desire of the public to protect them and their habitats.

4.2.11.1 Historic Conditions

Factors regarding the historic and existing conditions for threatened and endangered species in the Study Area principally stem from the alteration, degradation, and loss of barrier habitats; and human disturbance. The continued high rate of land loss throughout the Study Area over the past 100 years continues to reduce available coastland resources to threatened and endangered species. This creates increased intra- and interspecific competition for rapidly depleting resources between not only the various threatened and endangered species but also other more numerous fauna. A more detailed description of the historic and existing conditions for those threatened or endangered species that may be found in the Study Area is provided in Appendix A.

The Endangered Species Act of 1973, as amended, requires the designation of critical habitat for all threatened and endangered species. Critical habitat is habitat essential for the conservation or recovery of an endangered or threatened species. In the July, 2001 Final Rule (Federal Register, Vol. 66, No. 132), the USFWS designated critical habitat for wintering populations of the endangered piping plover (Figures 4-12 and 4-13).

4.2.11.2 Existing Conditions

Within the State of Louisiana there are 29 animal and 3 plant species (some with critical habitats) under the jurisdiction of the USFWS and/or NMFS, presently classified as threatened or endangered (Table 4-10). The USFWS and NMFS share jurisdictional responsibility for sea turtles and the Gulf sturgeon. Of the animals and plants under USFWS and/or NMFS jurisdiction, no plant species and only 7 animal species are potentially within the Study Area (including borrow areas).

Table 4-10. Threatened and Endangered Species in Louisiana

Classification	Species	Scientific Name	Status	Jurisdiction	Found in Study Area?
Mammals	Florida Panther[a]	*Felis concolor coryl*	Endangered	USFWS	No
	Red Wolf1	*Canis rufus*	Endangered	USFWS	No
	West Indian Manatee	*Trichechus manatus*	Endangered	USFWS	Yes
	Louisiana Black Bear	*Ursus americanus luteolus*	Threatened	USFWS	No
Birds	Bachman's Warbler[b]	*Vermivora bachmanii*	Endangered	USFWS	No
	Eskimo Curlew	*Numenius borealis*	Endangered	USFWS	No
	Ivory-billed Woodpecker[a]	*Campephilus principalis*	Endangered	USFWS	No
	Least Tern; interior population	*Sterna antillarum*	Endangered	USFWS	No
	Red-cockaded Woodpecker	*Picoides borealis*	Endangered	USFWS	No
	Piping Plover	*Charadrius melodus*	Threatened	USFWS	Yes
Reptiles	Hawksbill Sea Turtle	*Eretomchelys imbricata*	Endangered	USFWS/NMFS	Yes
	Kemp's (Atlantic) Ridley Sea Turtle	*Lepidochelys kempii*	Endangered	USFWS/NMFS	Yes
	Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	USFWS/NMFS	Yes
	American Alligator[c]	*Alligator mississippiensis*	Threatened	USFWS	No
	Gopher Tortoise	*Gopherus polyphemus*	Threatened	USFWS	No
	Green Sea Turtle	*Chelonia mydas*	Threatened	USFWS/NMFS	Yes
	Loggerhead Sea Turtle	*Caretta caretta*	Threatened	USFWS/NMFS	Yes
	Ringed Sawback Turtle	*Graptemys oculifera*	Threatened	USFWS	No
	Snake, Louisiana Pine	*Pituophis ruthveni*	Candidate[d]	USFWS	No
Fish	Pallid Sturgeon	*Scaphirhynchus albus*	Endangered	USFWS	No
	Gulf Sturgeon	*Acipenser oxyrinchus desotoi*	Threatened	USFWS/NMFS	No
	Dusky Shark	*Carcharhinus obscurus*	Candidate[d]	NMFS	No
	Sand Tiger Shark	*Odontaspis taurus*	Candidate[d]	NMFS	No
	Night Shark	*Carcharinus signatus*	Candidate[d]	NMFS	No

Classification	Species	Scientific Name	Status	Jurisdiction	Found in Study Area?
	Speckled hind	*Epinephelus drummondhayi*	Candidate[d]	NMFS	No
	Saltmarsh topminnow	*Fundulus jenkensi*	Candidate[d]	NMFS	No
	Jewfish	*Epinephelus itajara*	Candidate[d]	NMFS	No
	Warsaw Grouper	*Epinephelus striatus*	Candidate[d]	NMFS	No
Invertebrates	Mussel, Fat Pocketbook	*Potamilus capax*	Endangered	USFWS	No
	Pink pearlymussel Mucket	*Lampsilis abrupta*	Endangered	USFWS	No
	Inflated (Alabama) Heelsplitter	*Potamilus inflatus*	Threatened	USFWS	No
	Louisiana Pearlshell	*Margaritifera hembeli*	Threatened	USFWS	No
Marine Mammals	Sperm Whale	*Physeter macrocephalus*	Endangered	NMFS	No
	Sei Whale	*Balaenoptera borealis*	Endangered	NMFS	No
	Humpback Whale	*Megaptera novaeangliae*	Endangered	NMFS	No
	Finback Whale	*Balaenoptera physalus*	Endangered	NMFS	No
	Blue Whale	*Balaenoptera musculus*	Endangered	NMFS	No
Plants	American Chaffseed	*Schwalbea americana*	Endangered	USFWS	No
	Louisiana Guillwort	*Isoetes louisianensis*	Endangered	USFWS	No
	Earth Fruit	*Geocarpon minimum*	Threatened	USFWS	No

[a] The Florida panther, red wolf, Eskimo curlew, and ivory-billed woodpecker are presumed to be extinct in the State.
[b] There has been no confirmed Bachman's warbler U.S. nesting ground sighting since the mid-1960s, however, several sightings of the species have occurred on wintering grounds during the last decade. This species may be extirpated in Louisiana.
[c] For law enforcement purposes, the alligator in Louisiana is classified as "Threatened due to Similarity of Appearance." They are biologically neither endangered nor threatened. Regulated harvest is permitted under State law.
[d] Candidate species are not protected under the ESA, but concerns about their status indicate that they may warrant listing in the future. Federal agencies and the public are encouraged to consider these species during project planning so that future listings may be avoided.

For a more complete description of all threatened and endangered species occurring within Louisiana, their critical habitat geographic designations, management objectives, and current recovery status, refer to the USFWS endangered species website http://www.fws.gov/endangered/. In addition, the USFWS has published a report that assigns each species a Listing Status, Lead Region, Population Status, Recovery Plan, Plan Stage Recovery Achieved, and Recovery Priority (USFWS 1996a).

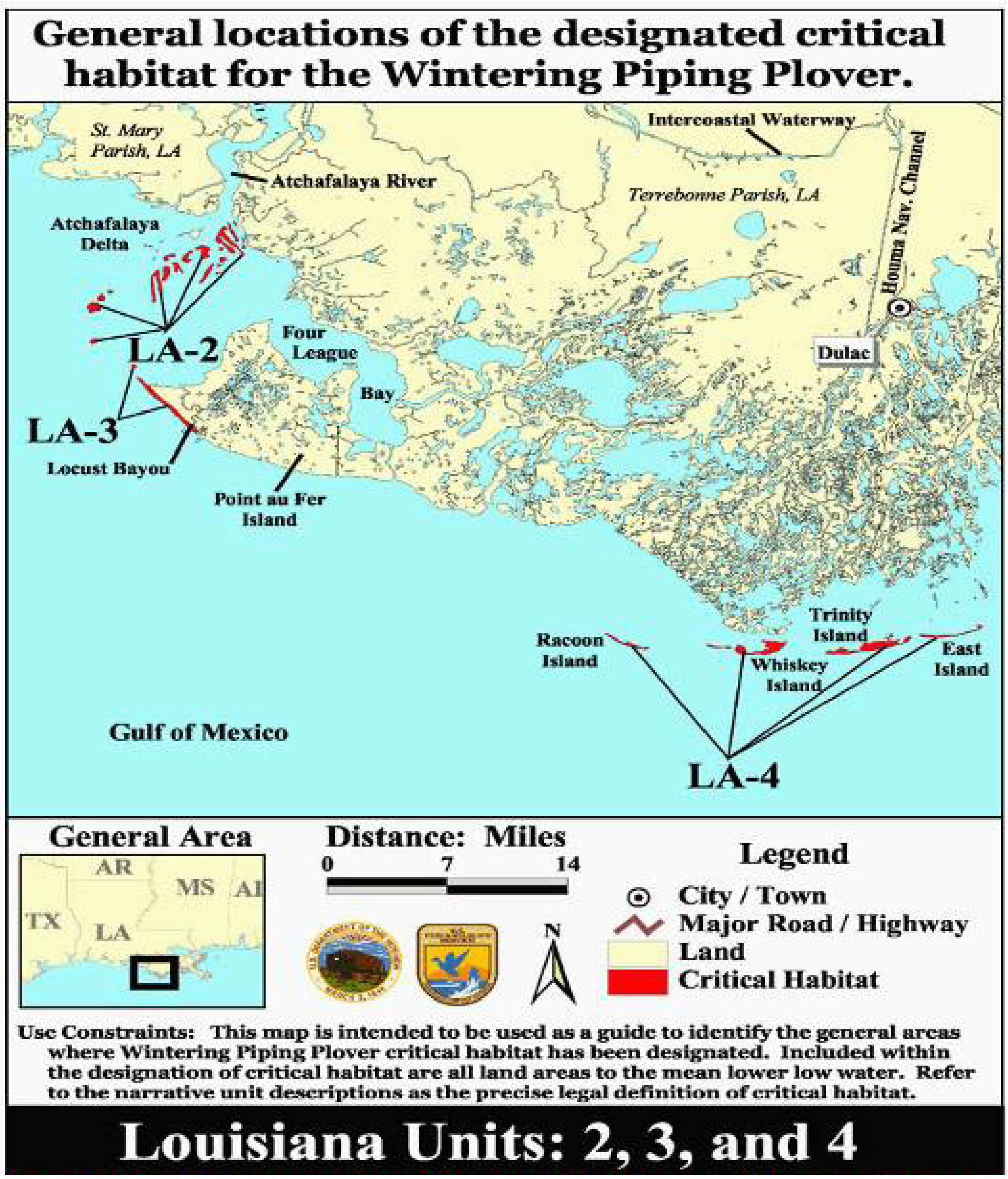

Figure 4-12. Wintering piping plover critical habitat

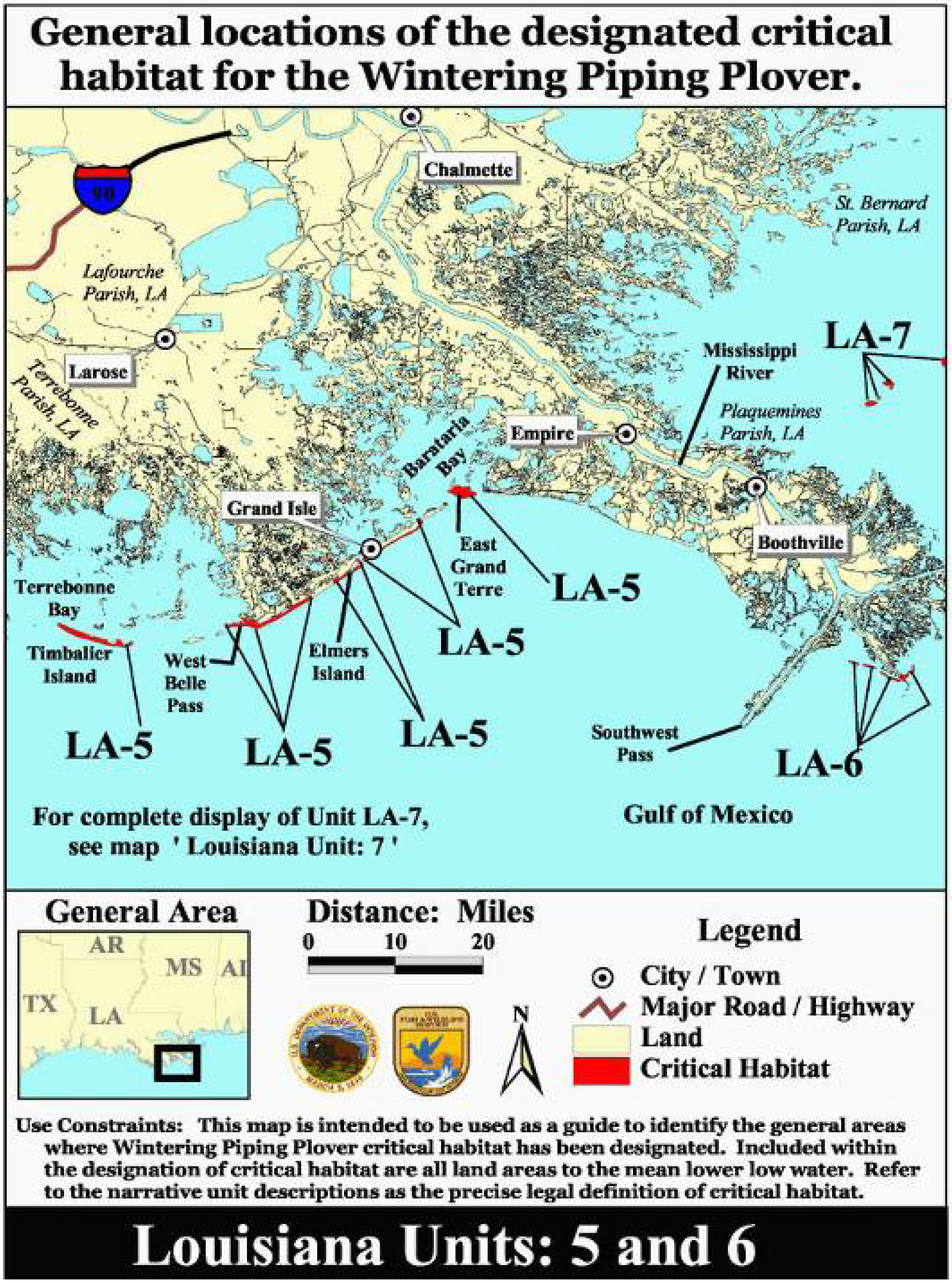

Figure 4-13. Wintering piping plover critical habitat

Coordination with the USFWS and NMFS has been initiated to determine potential impacts of the proposed action on threatened and endangered species and their critical habitats. A Biological Assessment (BA) was prepared (see appendix A Biological Assessment) to address potential impacts to piping plover critical habitat. Portions of this section concerning organisms under the jurisdiction of the USFWS were coordinated and prepared with input from members of the USFWS, Lafayette Field Office, Endangered Species Section. Portions of this section concerning organisms under the jurisdiction of NMFS were coordinated with input from members of the NMFS Endangered Species regional office in Florida.

Threatened and endangered species outside of the Study Area would not likely be affected by the proposed action. There are no known threatened or endangered floral species in the vicinity of the proposed action. Piping plovers may winter in or near the Study Area, frequenting outer beaches and occasionally foraging on mudflats within the Study Area. Much of the Study Area is designated as critical habitat for the Piping plover. The West Indian manatee has been reported in the Barataria-Terrebonne estuary during the summer months and may be a rare visitor in the Study Area. Threatened and endangered sea turtles typically frequent the Louisiana coast as they forage in estuarine waters.

Five endangered whale species might be present in offshore Louisiana waters. During aerial surveys conducted May 1980 - April 1981 in the region south of Marsh Island, Louisiana, there was only one sighting of endangered whales (Fritts et al., 1983). The sighting was of a pod of four sperm whales about 229-km (142 miles) south of Marsh Island. Other endangered whale species have been previously sighted off Louisiana, but they are typically found in water greater than 1,000 m (3,300 ft) deep (Schmidly, 1981; Fritts et al., 1983). The final programmatic BA for the Louisiana Coastal Area Ecosystem Restoration Study (USACE, 2004b) indicates a low potential for impacting cetaceans with proposed restoration measures, which includes the present study, across the entire coastal Louisiana area. A total of 28 cetaceans have been reported in the Gulf of Mexico waters (Davis et al., 2002; see also http://www.fws.gov). Of these, five Mysticeti [i.e., baleen whales including the blue whale (*Balaneoptera musculus*), finback whale (*Balaenoptera physalus*) and sei (*Balaenoptera borealis*); and Odontoceiti [i.e., toothed whales including the humpback (*Megaptera novaeangliae*) and sperm whale (*Physeter macrocephalus*)] have been reported in the Gulf of Mexico and all are listed as endangered species. Strandings of whales have occurred throughout the Gulf coast. However, the infrequent historical sightings and strandings in the Study Area of these endangered cetaceans suggest that most of these species are rare, accidental, or uncommon. All whales are principally marine deepwater species and would not likely be impacted by the proposed action.

There are three species of turtle (Hawksbill, Kemp's Ridley, and Leatherback) classified as endangered and two species of turtles (Green and Loggerhead) classified as threatened which may occur in the Study Area. Any of the turtles could potentially inhabit the general vicinity of the coastal portions of the Study Area (NMFS and USFWS, 1991a, 1991b; NMFS and USFWS, 1992a; USFWS and NMFS, 1992b; NMFS and USFWS, 1993). Both green and hawksbill sea turtles are more tropical in their distribution and rarely seen in the north central Gulf. The remaining species have been sighted in Louisiana coastal waters. Fritts et al. (1983)

sighted 15 loggerhead sea turtle individuals and two leatherback sea turtle individuals. Hard shelled (probably loggerhead) sea turtles were found to be present in consistent numbers during surveys off Louisiana in April 1987 (0.04 turtles/km^2) and October 1987 (0.05 turtles/km^2) (Lohoefener et al., 1988). Leatherback sea turtles, however, showed greater abundance during the October 1987 survey (0.027 turtles/km^2 than during the April 1987 survey (0.004 turtles/km^2). The reason for the absence of the Kemp's Ridley sea turtle in these surveys is unknown; however, these turtles are known to be common inhabitants of the shallow coastal waters between Marsh Island and the Mississippi River Delta. Coastal Louisiana appears to be an important habitat for sub-adults as well as a feeding habitat for this species (Hildebrand, 1982).

The Terrebonne Basin barrier island chain falls entirely or partially within two conservation areas, the State-managed Isle Dernieres Barrier Islands Refuge and the Barataria-Terrebonne National Estuary Program (BTNEP; a Federal-State cooperative). Conservation areas, or "refuges", have been established in this area to provide a multitude of management goals. A few fundamental goals that are key to the protection of threatened and endangered species include: 1) to preserve and restore wetlands and barrier islands; 2) to realistically support diverse natural biological communities; and 3) to formulate indicators of estuarine ecosystem health and balance estuary use (Showalter and Schiavinato, 2004).

Birds

Louisiana's coastal wetlands provide habitat for many threatened and endangered bird species. Though there are five threatened and endangered bird species that have been identified in the Barataria-Terrebonne system, only the piping plover uses the barrier islands for nesting and foraging (LDNR, 1998). The brown pelican, formerly on the threatened and endangered species list was removed from the list in 2009 (Federal Register: November 17, 2009 (Volume 74, Number 220)).

Piping Plover

The piping plover, a relatively small member of the shorebird family, exhibits strong migratory behavior, but is highly restricted to coastline margins (beaches, mudflats, etc.). Though the winter distribution of the piping plover spans the Atlantic and Gulf coasts, the highest concentration of birds have been reported in Texas, Louisiana, and Florida. However, only 63% of the breeding birds counted in a 1991 survey were identified during the following winter census, suggesting that important wintering areas are still unknown (USEPA, 2006). On January 10, 1986, the piping plover was federally listed as endangered in the Great Lakes watershed, and as threatened elsewhere in its range. In 2001, critical habitat for the wintering population was designated for 142 areas along the coast of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas. The purpose of this designation was to provide sufficient wintering habitat (and appropriate geographic distribution) to support population level recovery of the piping plover species (USACE, 2004b).

Piping plovers winter in Louisiana, and may be present for 8 to 10 months annually. They arrive from breeding grounds as early as late July and remain till late March or April. Piping plovers feed extensively on intertidal beaches, mudflats, sand flats, algal flats, and was-over passes with no or very sparse emergent vegetation; they also require unvegetated or sparsely vegetated areas for roosting. Plovers move among sites as environmental conditions change, and studies have indicated that they generally remain within a 2-mile area. Major threats to this species include loss and degradation of habitat due to development, disturbance by humans and pets, and predation (USFWS, letter dated March 4, 2010).

The primary constituent elements for piping plover critical habitat (wintering) are found in geologically dynamic coastal areas. Adjacent unvegetated or sparsely vegetated sand, mud, or algal flats above high tide are also important for roosting plovers (USACE, 2004b). Piping plover nests are situated above the high tide line on coastal beaches, sandflats at the ends of sandspits and barrier islands, gently sloping foredunes, blowout areas behind primary dunes, and washover areas cut into or between dunes. They may also nest on areas where suitable dredge material has been deposited. Nest sites are shallow scraped depressions in substrates ranging from fine grained sand to mixtures of sand and pebbles, shells or cobble (USFWS, 1996). Nests are usually found in areas with little or no vegetation, although on occasion, piping plovers will nest under stands of *Ammophila breviligulata* (American beachgrass) or other vegetation (USFWS, 1996).

Many of Louisiana's barrier islands, and coastal landforms and shorelines have been designated as critical piping plover habitat (USACE, 2004b). Included in that designation are the Isles Dernieres and Timbalier Islands reaches. In recent decades, numerous wintering surveys have been performed to identify active nesting colonies on the islands. The results of these surveys show active populations for Raccoon Island (1991: 129 individuals; 2001: 32 individuals), Trinity Island (1988: 34 individuals; 1991: 29 individuals; 1992: 57 individuals; 1996: 45 individuals), Whiskey Island (2001: 40 individuals), East Island (1996: 29 individuals), Timbalier (2001: 78), and an unnamed sand island between Timbalier Island and East Timbalier Island (2001: 108) (Ferland and Haig, 2002). Identifying piping plover habitat, populations, and activity are important since these birds are known to return to the same wintering sites year after year (USEPA, 2006).

Endangered and Threatened Sea Turtles

The aforementioned species of endangered and threatened sea turtles have historically visited and foraged along the Louisiana coast and barrier islands (though the hawksbill is rare in the Gulf; and leatherbacks prefer offshore waters). Sea turtles are long-lived, slow-reproducing animals that spend nearly all of their lives in the water. They require three major habitats: nesting beaches, pelagic developmental habitats, and benthic feeding habitats for juveniles and adults (USEPA, 1997a).

Kemp's Ridley Sea Turtle

On December 2, 1970 the *Lepidochelys kempii* (Kemp's ridley) sea turtle was designated as endangered across its range and its population has continued to decline in Louisiana (USACE, 2004c). Its nesting areas and habitats include barrier islands (particularly in south Texas), and nearshore habitats (especially the crab-rich waters off the mouth of the Mississippi River) along the Gulf coast. The sheltered estuaries, bays, and lagoons of Louisiana are primary developmental areas and feeding grounds for the Kemp's ridley (USACE, 2004b).

Occurrence of these sea turtles in bays and estuaries along the Louisiana coast would not be unexpected, as many of their primary food items occur there. Stomach analyses of specimens collected in shrimp trawls off Louisiana revealed crabs, gastropods, and clams Trawlers have also reported seeing this turtle species frequently in Louisiana waters, The Kemp's Ridley accounts for 60% of all strandings in Louisiana, with 52% of those occurring in the vicinity of the Isles Dernieres Islands (USEPA, 2005b).

Green Sea Turtle

The *Chelonia mydas* (green sea turtle) was listed as endangered/threatened on July 28, 1978. The breeding populations off Florida and the Pacific coast of Mexico are listed as endangered while all others are threatened. This species' current status in Louisiana is unknown (USACE, 2004b).

Hawksbill Sea Turtle

The *Eretmochelys imbricate* (hawksbill turtle) was listed as an endangered species in June 1970 and its current status in Louisiana is unknown. Only one record of a hawksbill in Louisiana has been reported. Hawksbill turtles nest at low densities in aggregations of 1 to 100 adults; in contrast, other sea turtles have concentrated nesting sites and aggregations of thousands of adults. Actions needed to achieve recovery include long-term protection of foraging habitat and nesting beaches, and reduction of illegal exploitation (USACE, 2004b).

Leatherback Sea Turtle

The *Dermochelys coriacea* (leatherback sea turtle) was listed as an endangered species throughout its range in June 1970 (USACE, 2004b). The leatherback sea turtle occurs mostly in continental shelf waters, but will occasionally enter shallow waters and estuaries. Adults are highly migratory, and are believed to be the most pelagic of all sea turtles. Habitat requirements for juvenile and post-hatchling leatherbacks are unknown. In Louisiana, leatherbacks are believed to occur offshore in deep waters; however, they have been collected from or sighted in Timbalier Bay, Cameron Parish, Atchafalaya Bay, and Chandeleur Sound (USACE, 2004b). Habitat destruction, incidental catch in commercial fisheries, and the harvest of eggs and flesh are the greatest threats to the survival of the leatherback. Recovery plans are directed at all leatherbacks within U.S. Caribbean, Atlantic, and GOM waters, whether they are nesting within these areas or elsewhere (USACE, 2004b).

Loggerhead Sea Turtle

The *Caretta caretta* (loggerhead sea turtle) was listed as a threatened species in July 1978 and its populations in Louisiana have continued to decline (USACE, 2004b). The largest of the hard-shell sea turtles, the loggerhead is distributed worldwide in temperate and tropical bays and open oceans. It is probable that the Loggerhead sea turtle ranges along the entire Louisiana coast; however, previous reports have documented specimens only from Chandeleur Sound, Barataria Bay, and Cameron Parish (USACE, 2004b). Although loggerheads have been documented as nesting on the Chandeleurs in 1962 and Grand Isle in the 1930s, it is doubtful whether this species currently successfully nests on the Louisiana coast. The decline in population has been attributed to egg and nestling predation by mammals and birds. Recent surveys by USFWS Refuge personnel have found no loggerhead nests in the area (USACE, 2004b).

Fish

The *Acipenser oxyrinchus desotoi* (Gulf sturgeon) the only threatened fish species listed in the GOM. On September 30, 1991, the Gulf sturgeon was listed as a threatened species under the ESA, and the USFWS designated critical habitat for this species throughout its range on February 28, 2003. The take of Gulf sturgeon is prohibited in the State waters of Louisiana, Mississippi, Alabama, and Florida. Section 6(a) of the ESA provides for extended cooperation with states for the purpose of conserving threatened and endangered species.

The sturgeon is a bottom-dwelling suction feeder (with a ventral, highly extrusible mouth), which, similar to catfish, detects prey with taste barbels. Subadults and mature adults participate in upriver migrations in the spring to spawn. During winter months adults move parallel to shore between estuary systems or offshore into deeper waters. The Gulf sturgeon inhabits coastal rivers from Louisiana to Florida during spring and summer, and the estuaries, bays, and marine environments of the GOM during fall and winter.

Mammals

The West Indian manatee was listed as endangered throughout its range for both the Florida and Antillean subspecies in 1967, and received Federal protection with the passage of the ESA in 1973. Critical habitat was designated in 1976, 1994, 1998, 2002, and 2003 for the Florida subspecies. The West Indian manatee is also protected under the Marine Mammal Protection Act (MMPA) of 1972. The MMPA establishes a national policy for the maintenance of health and stability of marine ecosystems and for obtaining and maintaining optimum sustainable populations of marine mammals. It includes a moratorium on the taking of marine mammals (USACE, 2004b).

In the warmer months, manatees disperse from winter aggregation areas, and are commonly found almost anywhere in Florida where water depths and access channels are greater than 3.3 to 6.6 ft (USACE, 2004b). In the warmer months, manatees usually occur alone or in pairs, although interacting groups of 5 to 10 animals are not unusual. A few individuals have been known to stray as far north as the northern Georgia coast and as far west as the coastal waters of Louisiana (USACE, 2004b).

Endangered West Indian Manatees occasionally enter Lakes Pontchartrain and Maurepas, and associated coastal waters and streams during the summer months (i.e., June through September). Manatees have been regularly reported in the Amite, Blind, Tchefuncte, and Tickfaw Rivers, and in canals within the adjacent coastal marshes of Louisiana. The manatee has declined in numbers due to collisions with boats and barges, entrapment in flood control structures, poaching, habitat loss, and pollution. Cold weather and outbreaks of red tide may also adversely affect these animals (USEPA, 2005b).

To avoid any impacts to the West Indian Manatee, the following measures must be incorporated into all contracts for this Study. All contract personnel associated with the Study should be informed of the potential presence of manatees and the need to avoid collisions with manatees, which are protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973. All construction personnel are responsible for observing water-related activities for the presence of manatee(s). Temporary signs should be posted prior to and during all construction/dredging operations or within vessel movement zones (i.e. work area), and at least one sign should be placed where it is visible to the vessel operator. Siltation barriers, if used, should be made of material in which manatees could not become entangled, and should be properly secured and monitored. If a manatee is sighted within 100 yards of the active work zone, special operating conditions should be implemented, including: no operation of moving equipment within 50 ft of the manatee; all vessels should operate at no wake/idle speed within 100 yards of the work area; and siltation barriers, if used, should be resecured and monitored. Once the manatee has left the 100-yard buffer zone around the work area on its own accord, special operating conditions are no longer needed, but careful observations should resume. Care should be taken to avoid entrapment of individual. Any manatee sighting should be immediately reported to the Service's Lafayette, Louisiana Field Office (337/291-3100) and the Louisiana Dept. of Wildlife and Fisheries, Natural Heritage Program (225/765-2821).

4.2.12 Cultural and Historic Resources

This resource is institutionally important because of: the National Historic Preservation Act of 1966, as amended; the Native American Graves Protection and Repatriation Act of 1990; and the Archeological Resources Protection Act of 1979; as well as other statutes. Cultural resources are technically important because of: their association or linkage to past events, to historically important persons, and to design and/or construction values; and for their ability to yield important information about prehistory and history. Cultural resources are publicly important because preservation groups and private individuals support their protection, restoration, enhancement, or recovery.

4.2.12.1 Historic Conditions

Humans have made a progressive mark on coastal Louisiana for thousands of years. Archaeological remains found in Louisiana indicate that man has occupied the area since around 10,000 B.C., primarily as nomadic hunter-gatherers that migrated with the fluctuations of the Mississippi River. The diverse resources available in coastal Louisiana have led to a diverse history and rich culture in the Louisiana coastal area. As a result, cultural resources are abundant in the region. Over the last 50 years, as land loss has progressed and saltwater intrusion has increased, many of these cultural resources have been put at risk or lost to erosion, inundation, and construction of canals (USACE, 2004a). The SHPO is charged with the responsibility of maintaining the central files of all the archaeological and historical standing structures data. All cultural resources survey reports and forms conducted under the National Historic Preservation Act (NHPA) are archived in their offices in Baton Rouge (USACE, 2004b).

Prehistoric sites include hunting and food processing camps, hamlets, and village sites. Native Americans relied on hunting, fishing, and gathering of plants. Types of historic sites include domestic buildings, plantation sites, farmsteads, military sites, commercial sites, industrial sites, boat landings, and hunting and fishing camps along the coast. In addition to terrestrial historic sites, the Study Area has the potential to contain historic shipwrecks. Watercraft from all time periods could be present in the Study Area. Most of the vessels used historically in this area were vernacular watercrafts (USACE, 2004b).

In the early 1900s, various subsistence activities that were initially developed prior to the 20th century became more commercial in nature. Seafood, one of the most important natural resources in south Louisiana, has continued to become more important to the economy of Louisiana. In the middle of the 19th century, methods of preservation such as the drying of shrimp and canning of oysters made it possible to export seafood. The introduction of the gasoline motor and refrigeration allowed fishermen greater access to markets in New Orleans and the larger towns inland from the coast. Seafood processing camps that had been established all over the coast in the 1800s, including Manila Village, Bayou St. Malo, and the Isle de Caminada, were abandoned after being hit by numerous tropical storms and hurricanes. In the 1900s, many of these fishermen established new settlement and seafood processing businesses along the major waterways leading away from the coast. Fishing remains a major economic activity in south Louisiana (USACE, 2004b).

Other industries developed in south Louisiana in the 1900s that have shaped the economy of the State. The oil industry began in the early 1900s and continues to be a major industry. Large oil fields are located in the marshy areas of south Louisiana and offshore. Pockets of sulfur and salt are located across south Louisiana. The extraction of these natural resources became major industrial activities. All of these economic activities have contributed to the constructed environment of south Louisiana. Historic standing structures, archaeological sites, and landscape features associated with man's activities in the coastal area may be significant cultural resources. The Division of Archaeology maintains information on over 12,000 archaeological sites and thousands of historic standing structures (USACE, 2004b).

4.2.12.2 Existing Conditions

The land in the Study area is eroding rapidly. The protection of these lands by some of the ongoing CWPPRA or other restoration projects may actually protect these sites in the long-term by stopping or slowing land erosion. Depending on the restoration features, the proposed actions could help to restore the surrounding wetlands, thus protecting the land and whatever cultural resources that may be located within the Study area.

Barrier Islands

A cultural resource assessment of six areas of potential effects (APEs) within the Study area was performed by R. Christopher Goodwin and Associates, Inc. in December 2009 (Nowak et al. 2010). The APEs investigated included the footprint of the design plans for each of the individual islands composing the Isles Dernieres and Timbalier barrier island reaches. The cultural resource assessment reviewed the geomorphology, prehistory, history and archaeology of the Isles Dernieres and Timbalier Islands to ascertain the probability for the presence of significant cultural resources, i.e., those archaeological sites and historic properties possessing the qualities of significance and integrity defined by the National Register of Historic Places Criteria for Evaluation (36 CFR 60.4[a-d]).

Research included the review of archeological site files within 10 miles of the of the barrier island APEs, the results of previous investigations conducted within one mile of the barrier island APEs, and databases (including the National Oceanic and Atmospheric Administration Automated Wreck and Obstruction Information System (AWOIS), the Minerals Management Service shipwreck database, and the Louisiana shipwreck database) reporting the locations of shipwrecks and obstructions within 10 miles of the barrier island APEs. The geomorphology of Isles Dernieres and the Timbalier Islands was also reviewed as it relates to the potential for the existence of significant cultural resources. Historic maps and charts dating from 1853 to the present were reviewed along with the results of previously conducted geomorphologic studies that endeavored to reconstruct the historic shorelines of these island chains. Finally, historical research was conducted in order to ascertain the nature and extent of historic navigation within the general vicinity of the Study Area.

The review and correlation of the geomorphology of the Study Area with the regional prehistory and archaeological record of this part of south Louisiana indicate a low probability for significant prehistoric archaeological sites or prehistoric watercraft within the barrier island APEs. Additionally, any prehistoric archaeological remains that exist within these areas likely will consist of reworked and/or redeposited accumulations of cultural materials lacking integrity and having little research value (36 CFR 60.4[d]).

Consideration of the geomorphology and history of the Study Area also suggests that there is a low probability for significant historic archaeological sites or standing structures since no historic occupations were noted on *terre firme* within the Study Area. However, various probabilities for the discovery of historic shipwrecks exist within the barrier island APEs, as summarized below.

Raccoon Island

Within the Raccoon Island APE, a high probability for historic shipwrecks is indicated near Raccoon Point, while a moderate probability for such resources is present to the east of this area. Ships could have grounded on shoals within these areas as they attempted to navigate the natural channels behind the island. A low probability for historic shipwrecks is indicated along the entire Gulf Coast of the island, since waters south of the shoreline within the APE were subaerially exposed until the mid-twentieth century.

Whiskey Island

The potential for historic shipwrecks within the Whiskey Island APE generally is similar to Raccoon Island. Although no reported historic shipwrecks are recorded within this area, and while ships traveling to and from the village on Isle Dernieres probably did not pass within the Whiskey Island APE, Confederate blockade runners probably did pass behind this reach of Isle Dernieres. As a result, the northwestern portion of the Whiskey Island APE has a moderate probability for historic shipwrecks. Areas within the APE south and west of this region were subaerially exposed until the mid-twentieth century; thus, they should be considered to have low potential for historic shipwrecks.

A Phase I submerged cultural resources remote sensing investigation was conducted by R. Christopher Goodwin and Associates, Inc. within the vicinity of Whiskey Island (Nowak et al. 2010b). Thirteen (13) targets exhibiting the potential to represent submerged cultural resources were identified, although none of the magnetic anomalies that compose those targets could be associated with side scan sonar contacts, suggesting that all thirteen (13) targets are buried.

Trinity and East Islands

The Trinity and East Island APE was largely subaerially exposed until the mid-twentieth century. Coastal Environments, Inc. (Kelley et al. 2009) recently studied a portion of the East Island APE, and no significant cultural resources were identified during that study. The Trinity and East Island APE is considered to have low probability for historic shipwrecks.

Wine Island

Modern Wine Island is a relatively recent landform. The area it occupies was open water prior to and during the nineteenth and early twentieth centuries. Ships entering or exiting Lake Pelto would have passed close to this area. One reported shipwreck, the schooner Lizzie Haas foundered in a gale near Wine Island during 1902. Considering the position of modern Wine Island near the eastern entrance to Lake Pelto, there is a moderate probability for historic shipwrecks within the Wine Island APE.

Timbalier Island

Three ships are reported to have been lost in the immediate vicinity of Timbalier Island. These include the sidewheel steamer Merchant, the schooner Thistle, and the bark Gerhardus (Birchett and Pearson 1998:21-24; Clune and Wheeler 1991; New York Times Jan. 22 1897). These ships were lost during 1842, 1877, and 1897, respectively. A portion of the Timbalier Island APE also was investigated recently by Coastal Environments, Inc. (Kelley et al. 2009). No significant cultural resources were identified during that study. As a result, only the areas immediately adjacent to but outside of the footprint of the aforementioned Coastal Environments, Inc. investigation can be considered to have a moderate potential for historic shipwrecks.

East Timbalier Island

East Timbalier Island is a relatively recent landform. The area it occupies was open water prior to and during the nineteenth and early twentieth centuries. No shipwrecks have been reported within the East Timbalier Island APE. However, ships sailed through the area now occupied by this island throughout the historic period and could have foundered within the APE. Normally, there would be a moderate probability for historic shipwrecks within such an area. However, review of oil and gas field data from the Louisiana Department of Natural Resources SONRIS system indicates that extensive disturbance has occurred within the East Timbalier Island APE. As a result, a low-to moderate probability exists for historic shipwrecks within the East Timbalier Island APE.

In addition, Trinity Island hosts the Whiskey Pass Silver King Association statue of the Madonna, which was originally placed on Whiskey Island by the Association in the 1960s, but was eventually moved to Trinity Island in the 1970s. Members of the Association have been responsible for occasionally moving the statue in order to protect it from degrading island conditions. R. Christopher Goodwin and Associates, Inc. investigated the Whiskey Pass Silver King Association statue of the Madonna on Trinity Island (Figure 2-19) and determined that the statue does not possess significance of associations with important historic patterns or events, for associations with important personages, for its qualities of design or construction, or for its potential to yield important information, as required under the National Register Criteria for Evaluation (36 CFR 60 [a-d]). The statue will be avoided or temporarily relocated during a restoration event.

Section 106 consultation was initiated with the Advisory Council on Historic Preservation (ACHP), SHPO, and federally recognized Indian tribes in May 2009. The results of the cultural resource assessment of the barrier island APEs revealed no known listed National Register of Historic Places properties or sites eligible for listing on the National Register of Historic Places, and the results of the cultural resource assessment were coordinated with the SHPO. In a letter dated March 22, 2010, the SHPO concurred with the general findings concerning the probabilities of prehistoric and historic cultural resources and shipwrecks within the APEs. The results of the Phase I remote submerged cultural resources remote sensing investigation in the vicinity of Whiskey Island have not yet been coordinated with SHPO or Indian tribes. However, in consultation with the ACHP, SHPO, Indian tribes, representatives of local governments, and other consulting parties, the USACE developed a Programmatic Agreement among the USACE, CPRA, SHPO, and ACHP, pursuant to 36 CFR § 800.14(b)(1), executed July 29, 2010. The Programmatic Agreement establishes the procedures for consultation, identification of historic properties, assessment and resolution of adverse effects, and is included in Appendix F. The execution and implementation of the Programmatic Agreement fulfills USACE obligations under Section 106 of the National Historic Preservation Act of 1966, as amended.

Borrow Areas

Five sediment sources have been identified for use as borrow for either beach and dune restoration or marsh creation and restoration. The five source locations have been investigated to determine if any historic properties exist within the area of potential effects (APE), and the results are summarized below. The locations of potential sites, possibly representing either historic shipwrecks or prehistoric sites, will be avoided, and the USACE will continue consultation with the SHPO and federally recognized Indian tribes, pursuant to the stipulations of the Programmatic Agreement.

Whiskey Island Restoration Borrow Area 3

Whiskey Island Restoration Borrow Area 3 is located approximately three miles south of Trinity Island in State waters. Water depths vary between -16 ft and -22 ft NAVD 88. Subsurface sand resource thickness ranges from 2.5 to 14.0 ft and is overlain by varying thicknesses of overburden ranging from 3.5 ft to 17.4 ft.

As part of a separate coastal restoration effort (TE-50), two integrated hydrographic/geophysical surveys were conducted within the Whiskey Island Restoration borrow area in 2006 (TBS and M&N 2007). The resultant surveys included the acquisition and analysis of more than 260 statute miles of multi-sensor marine geophysical data (sounding, seismic/sub bottom Chirp profiling, and magnetic) in a LDNR-approved search area. Remote-sensing cultural resource investigations of Subarea 3a revealed several areas where magnetic anomalies were detected. Of the 247 magnetic anomalies identified, only twenty-four were considered to be potentially significant cultural resources and recommended for avoidance by Archaeological Resources, Inc. (TBS and M&N 2007). The borrow area limits and avoidance area are included in Appendix L.

New Cut Borrow Area 4

The New Cut Borrow Area 4 is an existing active borrow area in State waters previously utilized by LDNR. Seismic and magnetometer surveys have been conducted throughout this borrow area. Avoidance area locations were developed based on these surveys and included on as-built drawings for the New Cut Dune/Marsh Restoration (TE-37) project. One avoidance area is located within the TE-37 excavation limit (Appendix L). The nature of this avoidance area could not be determined from the existing information. The borrow area limits and avoidance area is included in Appendix L.

Raccoon Island Restoration Borrow Area 5

The Raccoon Island Restoration Borrow Area 5 is located approximately four to six miles south of Raccoon Island in Federal waters. The bottom depth at the north end of the borrow area is -23.5 ft (NAVD 1988), sloping downward to -26.5 ft (NAVD

1988) at the lower end (SJB et al., 2006). A remote-sensing cultural resources investigation, which included approximately 100 nautical miles of remote sensing side-scan and magnetometer surveys was conducted at this location in 2008 (Goodwin 2008). Based on this investigation the borrow area was refined to approximately 600 ft in width and 10 to 20 ft in depth.

Review of the geology, prehistory, and history of the investigated area indicate that there is low potential for the discovery of both submerged prehistoric cultural resources and for the discovery of submerged historic cultural resources, such as shipwrecks. The magnetometer data indicated one pipeline, one anomaly cluster that may represent a pipeline, and three anomaly clusters that may represent significant submerged cultural resources. No potentially significant side-scan sonar contacts were identified. The report recommended avoidance of the abovementioned anomalies. The borrow area limits and avoidance areas are included in Appendix L.

South Pelto Borrow Area 6

South Pelto Borrow Area 6, which includes MMS South Pelto Lease Blocks 12 and 13, is located in Federal waters of the Gulf of Mexico approximately 9.5 miles south of Isle Dernieres. Water depths in the borrow area range from 26 to 48 ft. A remote-sensing cultural resources investigation, which included side-scan and magnetometer surveys was conducted in 2003 (C & C 2003b). The survey was conducted according to MMS guidelines at that time, which required 50-meter grid spacing. Numerous sonar targets and magnetometer anomalies were recorded. Based on these findings, ten avoidance areas were proposed within the borrow area. The borrow area limits and avoidance areas are included in Appendix L.

Ship Shoal Borrow Area 7

Ship Shoal Borrow Area 7, which includes MMS Lease Blocks 87, 88, 89, 94, and 95, is located in Federal waters of the Gulf of Mexico approximately 10 miles south of Whiskey Island. The hydrographic conditions across most of the borrow site are relatively flat, with the controlling depths ranging from -17 to -23 ft NAVD 88. All of these lease blocks are identified by the MMS as high probability areas relative to prehistoric archaeological site potential and Blocks 88, 89, and 94 are identified as high probability blocks relative to historic shipwreck potential. Ship Shoal deposits have the potential for containing cultural remains dating to the Middle Archaic period (circa 7,000 to 5,000 years B.P) (C & C 2003a). Evidence suggests that Ship Shoal deposits have been churned, reworked, and extensively burrowed over the past several thousand years such that any cultural remains contained in them have been disturbed and will not be in situ (Penland et al. 1985).

Substantial geophysical surveys which included side-scan sonar and magnetometer surveys were conducted along lines spaced at 50-meter intervals across the borrow area as part of a separate coastal restoration effort (C & C 2003a). Based on these surveys, two areas were recommended for avoidance because of potentially significant cultural resources. The borrow area limits and avoidance areas are included in Appendix L.

4.2.13 Aesthetics

4.2.13.1 Historic Conditions

This resource's institutional significance is derived from laws and policies that affect visual resources, most notably the National Environmental Policy Act of 1969, the Coastal Barrier Resources Act of 1990. This resource is technically significant because of the visual accessibility to unique geological and botanical features that are an asset to the Study Area. Public significance is based on expressed public perceptions and professional evaluation.

It is National policy that aesthetic resources be protected along with other natural resources. Current planning guidance specifies that the Federal objective of water and related resources planning is to contribute to National Economic Development consistent with protecting the Nation's environment (ER 1105-2-100). The Corps established a number of environmental goals, including: (1) Preservation of unique and important aesthetic values; and, (2) Restoration and maintenance of the natural and man-made environment in terms of variety, beauty, and other measures of quality (ER 200-2-2). The Visual Resources Assessment Procedure (VRAP), WES Instructional Report EL-88-1, will be used to:

1. Identify and assess the existing visual resources conditions affected by the study.

2. Assess (describe magnitude, location, duration) and appraise (determine if beneficial or adverse) the visual impacts caused by alternatives.

3. Provide a replicable basis of support for any recommended mitigation.

The purpose of using this procedure is to have a systematic approach to consider aesthetic resources. Advantages of a systematic and quantifiable approach include the ability to assign a visual resource value to all of the landscape units within a Study Area, identify significant aesthetic resources, and to determine causes of adverse impact. Such a procedure provides a clear, tractable basis for including aesthetics in plan formulation, design, reformulation, and mitigation planning. As such, the VRAP is consistent with existing Federal and Corps water resources planning and environmental policies and regulations.

Data sources describing the historical aesthetic condition of the Study area are limited. Sothern (1980) described Last Island (the chain of islands making up Isles Dernieres) as "a popular resort visited by well-known, prominent people from throughout the State". Sothern (1980) provides general descriptions of the island obtained from newspaper articles from the mid-1800s promoting Last Island as a vacation destination and an escape from the yellow fever epidemic of 1853. Historical accounts and a United States Coastal Survey Map of 1853 indicate that most of the dwellings as well as a hotel were situated near the western end the island facing the Gulf. The following account published in the Planters Banner in 1848 was included by Sothern (1980) and provides and vivid account of the historic aesthetics enjoyed by vacationers on Isles Dernieres in the 1800s:

"The beach is smooth, and covered with small white shells, the water is clear and salt, and not over five ft deep, for a distance of two hundred yards form the shore, and when the tide is coming in, the waves roll upon the beach one after another in so beautiful succession, that any one who looks upon them must be highly gratified at the sight. This beach is certainly one of the finest places for promenading I have ever seen. Its surface is smooth and firm, it is always cool on account of its being contiguous to the salt water which so uniformly washes its surface, a gentle sea breeze is always floating across it, and health and vigor seemed to be inhaled at every breath by those who visit it" (Sothern 1980).

4.2.13.2 Existing Conditions

Visually the Terrebonne Basin barrier islands owe their diversity to variations in flora and fauna, and the interface of the GOM and marsh. The surf and songs of numerous birds offer a variety of sounds. For many visitors, the smell and feel of salty air, and the variety of nature, add to the appeal of the islands (USEPA, 1993). Today the remains of fishing camps and petroleum-related infrastructure dominate the barrier islands' human-made landscape.

The Isles Dernieres and Timbalier Barrier Islands are low-lying strips of land ranging from approximately 0.1 to 0.85 miles wide and are typically composed of a thin sand cap over a thick mud platform. Elevations are generally low and the islands are frequently overwashed (USACE, 2004c). From a typical view from the bayside of the islands facing gulfward, one would encounter shallow unvegetated subtidal flats gradually transitioning into a smooth cordgrass and mangrove-dominated salt marsh. Just beyond the marsh and mangrove flats, one will encounter a sparsely-vegetated saltpan then a grassy swale and shrub-dominated barrier flats. Low-lying dunes are covered with marshhay cordgrass, goldenrod, and coastal dropseed. The low-lying dunes would be frequently bisected by overwash fans from recent storms. Moving gulfward, one would encounter a sparsely-vegetated beach littered with driftwood and miscellaneous artifacts from the commercial fishing and petroleum extraction industries. From almost any view gulfward, one would observe commercial fishing boats and oil and gas platforms in the nearby gulf waters.

4.2.14 Recreation

4.2.14.1 Historic Conditions

Early accounts of recreational activities on Isles Dernieres were provided in Sothern (1980). In leading up to the tragic hurricane of 1856, Sothern documents the transition of Last Island from a fishing village to a resort frequented by wealthy plantation owners during the summer months. The yellow fever epidemic in 1853 made the barrier islands more attractive because common belief at the time was that the disease was rarely contracted in saltwater environments. Caillou Island and Timbalier Island appeared to have been favorite destinations for residents from Terrebonne Parish, while the planters along Bayou Teche and upper Bayou Lafourche preferred Last Island. Bathing, fishing, hunting, and exploring were common recreational activities reported during the 1800s.

4.2.14.2 Existing Conditions

Louisiana possesses approximately eight million acres of coastal lands, marshes, lakes, swamps and bays, and approximately 13 million acres of forests. These resources and the recreation activities in which they support (sport fishing, hunting, boating, water skiing, swimming, hiking, and camping) have grown considerably in recent years. Not only have the number of recreationally linked visits to these facilities and natural areas increased, but over the last decade so have the diversity of non-traditional settings and activities. According to the USFWS National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Louisiana Department of Culture, Recreation, and Tourism, 2006) and the Louisiana Department of Wildlife and Fisheries study on *The Economic Benefits of Fisheries, Wildlife and Boating Resources in the State of Louisiana – 2006* (2008d):

- 1.2 million Louisianans, ages 16 and over, participated in wildlife-associated recreation. This figure represented 28%of the population. The national percentage is 20.

- Of the 1.2 million Louisiana sports persons ages 16 and older, 702,000 fished, 270,000 hunted, and 738,000 enjoyed both fishing and hunting. Louisiana's proportion of the sports in these categories was slightly higher than the national average.

- In 2006, state residents and non-residents 16 years and older who fished in Louisiana numbered 702,000. Of this total, 590,000 anglers (84%) were state residents and 112,000 anglers (16%) were non-residents. Resident and nonresident anglers fished a total of 11.2 million days in Louisiana – an average of 16 days per angler.

- Eighty-six percent of the State's 549,000 freshwater anglers were state residents.

- Eighty-six percent of the 289,000 saltwater anglers were state residents.
- 706,000 state participated in wildlife watching activities in Louisiana.
- 193,000 people (27% of all wildlife watchers in Louisiana) participated in wildlife watching activities at least 1 mile from their home. Of these, 203,000 were state residents and 111,000 were non-residents.

The majority of these recreational activities and facilities are located in the Louisiana coastal zone. These activities are often linked to localized heritage, tradition, prominent commerce, or other historical events. Examples of these are the hundreds of cuisine, wildlife, industry, and culturally-based festivals that are celebrated throughout the coastal zone.

Much of the recreation data has been extracted from the 2009 – 2013 Louisiana Statewide Comprehensive Outdoor Recreation Plan (SCORP), which is updated at five-year intervals (SCORP, 2003). The SCORP not only inventories statewide recreation resources, but also identifies and prioritizes the areas of need. Additional information on outdoor recreational activity in Region 3 can be found in Appendix E of the 2003 SCORP Report.

The Study Area is located within Region 3, which includes Terrebonne and Lafourche Parishes along with Assumption, St. James, St. Johns and St. Charles Parishes. Detailed data on outdoor recreational activity in Region 3 is contained in Appendix E of the 2003 SCORP Report.

Additional data were obtained from the Louisiana Department of Wildlife and Fisheries web site (http://www.wlf.louisiana.gov/education/economics/). According to The Economic Benefits of Fisheries, Wildlife and Boating Resources report (Southwick Associates 2006), "The fish, wildlife and boating resources of Louisiana generate substantial benefits. Hundreds of thousands of people depend on these resources for recreation, employment and as a source of food for their families. These valuable resources, actively managed by the Louisiana Department of Wildlife and Fisheries, not only contribute to the standard of living and economic health of state residents, but also to the common good through state tax revenues." The total impact of these activities amounted to:

- $4.61 billion of Retail Sales
- $6.75 billion of total Economic effect
- $446.2 million State and Local Tax Revenues
- 76,700 jobs supported

Sportspersons and wildlife watchers spend $110 billion annually, 1.1% of the Nation's gross domestic product. Preliminary findings in the State of Louisiana, from the USFWS 2001 FHWAR, show that 970,000 sportspersons participated in fishing with expenditures of $694,978 and 333,000 participated in hunting with expenditure of $416,953. Wildlife-watching participants numbered 802,000 resident and 314,000 nonresident with expenditures of $165,746. In this region of the country, 19% of the population are anglers, 9% are hunters, and 25% participate in wildlife-watching activities.

Americans traveling to Louisiana spent approximately $9 billion in 2007. This supported over 178,000 jobs in the State with annual income of about $2.8 billion. Tax revenues associated with recreation and tourism in Louisiana were about $5.9 billion for all levels of government. Thus, tourism is an important resource in the State of Louisiana (www.crt.state.la.us).

The Louisiana SCORP included some general needs and needs for specific regions. Some of the general needs included the need for more quality accommodations and camping facilities with more activities; the need to improve access to lakes for the average public; the need to enlarge timber-vegetated buffer strips of timber along streams, roads, and lakes to preserve plant communities and enhance water quality by filtering stormwater runoff, the need for more and improved local recreational opportunities; the need for more intense trail systems; the need for more regional promotion and packaging of outdoor recreation; the need for urban wilderness parks; and the need for public education on conservation and facility use. Table 4-11 displays Federal, State, and other important recreational resources.

Table 4-11 Federal, State, and other areas of important recreational resources

Wildlife/Recreation Areas	State Total	Terrebonne Basin
USFWS National Wildlife Refuges	16	1
National Historic Parks and Preserves	6	0
Louisiana Wildlife Management Areas and Refuges	36	2
Louisiana State Parks	17	0
State Historic Sites	12	0
Important Bird Areas	15	2
Scenic Byways	16	1
Annualized Unit Day Value (UDV)*	$4.05 billion	$66.1 million

The Louisiana SCORP inventoried over 104,000 acres (42,120 ha) of recreational facilities (these are public facilities and acres, and do not account for private lands and leases) for SCORP Region 3 (roughly Terrebonne Basin). Region 3 includes Terrebonne, Assumption, St. James, St. John, St. Charles, and Lafourche Parishes. Public lands in the Terrebonne Basin includes one USFWS National Wildlife Refuge, the Mandalay National Wildlife Refuge; one wildlife management area (WMA), the Pointe-Au-Chein WMA, and one Scenic Byway, the Lafourche-Terrebonne Scenic Byway (Wetlands Cultural Trail) that has routes through portions of southern Terrebonne Parish. The Terrebonne Barrier Island Refuge includes portions of Raccoon, Whiskey, and Trinity Islands.

With the inclusion of private lands, more than 107,000 acres (43,335 ha) are available for hunting. The region also has 194 boat lanes at 105 boat ramps; 131 acres (53.1 ha) with 365 tables for picnicking; 1 beach of 37 acres (14.9 ha); and 71 acres (28.7 ha) for camping with 34 tent sites and 422 trailer-sites. These resources alone are conservatively estimated to have an annualized UDV of over $286 million.

The SCORP prioritized needs in this region/subprovince, which include the need to maintain cultural heritage while increasing benefits associated with outdoor recreation and tourism, the need to promote and improve upon what is there (e.g., fishing, marsh, foods, etc.), the need for more public access to marshes, the need to protect the barrier islands, and the need to provide aid to recreation-related businesses.

The extensive marsh wetlands, water bodies, beaches and barrier islands of Louisiana's coastal area are ideally suited for outdoor recreational activities. The biological wealth and productivity of these natural resources support many species of native plants and animals, and also provide for a variety of recreational pursuits. Major recreational activities occurring in the coastal area, specifically in and around barrier islands include sport fin-fishing (the most popular); waterfowl, recreational shrimping; boating; swimming; sailing; picnicking; camping; hunting; bird watching; and observing wildlife.

There are limiting factors on the potential recreational use of these abundant resources. These limiting factors include private land ownership, lack of public access, and competition with commercial activities such as commercial fishing and shrimping, and mineral exploration and extraction. The ever-increasing loss and shifting of the barrier islands resource itself is also a factor, limiting potential recreational use. Many of the camps located on the barrier islands are privately owned and are not available to the general public. Public access to the barrier islands are provided by public boat launching facilities found throughout the Study Area. Generally, these facilities are located along the developed ridges of land that extend along the Mississippi River or its former meanders into the marshlands. Approximately 30 boat-launching facilities provide recreational boat access to the Study Area's barrier islands.

Saltwater finfish species, such as spotted sea trout and redfish, are taken recreationally. Crabs, shrimp, and flounder are also a significant part of the recreational fishery. Waterfowl hunting is predominant in the wetlands protected by the barrier islands. This is because the marshes lie within the Mississippi Flyway, which is used extensively by many migratory birds.

The barrier islands of the Terrebonne Basin are also a resting area for migratory neo-tropical songbirds and waterfowl. Many of these birds are passing through coastal Louisiana on their way to nesting areas northward.

Many local and out-of-state sportsmen use numerous marsh camps that serve on a seasonal or weekend basis of operation as a starting point for various outdoor activities. Many of these camps, which are only accessible by boat, serve as clubhouses for the coastal area's numerous fishing and hunting clubs. Others are privately owned and are used almost exclusively for family oriented recreation. Numerous camps are located in the Study Area.

Hunting and fishing are the primary recreational activities along the Terrebonne Basin barrier island chain. The use of watercraft is required for access to, and recreational use, of the barrier islands and associated marshes. The recreational use of the islands provides business for private boat launches, sport-fishing charters, and local supply companies (USFWS, 2003). Recreation in the Study area has benefited from the Louisiana Statewide Comprehensive Outdoor Recreation Plan. This plan has worked to prioritize recreational needs and requirements, and to promote interaction and cooperation between the local, State, Federal, and private recreation programs (USACE, 2004b). Also benefiting from these recreational plans are the commercially and recreationally important fishes and shellfishes (i.e. red drum, blue crab, white shrimp and the American oyster), which frequent the barrier islands and wetlands located within the Study area (USFWS, 2003).

Continued barrier island and wetland loss would significantly affect recreational resources and activities in coastal Louisiana (USFWS, 2003). Reductions in these activities would have devastating effects since recreational activities have been shown to improve the quality of life, and are key components of the State's tourism and economic development plans.

4.2.15 Socioeconomics and Human Resources

This resource is institutionally significant because of the National Environmental Policy Act of 1969; the Estuary Protection Act; the Clean Water Act; Section 122 of the River and Harbors Acts; the Watershed Protection and Flood Protection Act; and the Water Resources Development Acts. Of particular relevance is the degree to which the proposed action affects public health, safety, and economic well being; and the quality of the human environment. This resource is technically significant because the social and economic welfare of the nation may be positively or adversely impacted by the proposed action. This resource is publicly significant because of the public's concern for health, welfare, and economic and social well being from water resources projects.

To place this resource in perspective, one should understand that the barrier islands of the Atlantic and Gulf of Mexico coasts present a complex picture of human adaptability in the face of environmental, social, and economic factors: factors that can be complementary or competitive and often under the control of the weather and other natural phenomena beyond the influence of man. Depending upon geography, man has fished, trapped, hunted, and/or farmed barrier islands, as well as salvaged shipwrecks and their flotsam and jetsam, for centuries. Other, less savory occupations, such as smuggling, moonshine distilling, and piracy have also been prevalent, because of the frequent geographic complexity and extreme difficulty of access without local knowledge. Jean Lafitte, Jose Gaspar, Black Caesar, Captain (Thomas) Kidd, and the "wreckers" of the Florida Keys and Key West, come to mind. The pre-Columbian Calusa Indians of the Southwest Florida coast created a thriving culture within the coastal barrier system. Their settlements were sited on numerous elevated mounds composed almost entirely of oyster, clam, and gastropod shells, evidence of the productivity of the wetland system on which they depended. In a similar manner, the Paleo-Indians of the Louisiana coast, residing on the natural levees and *chenieres* but dependent on the natural resources of the adjacent marshes, left mounds or middens containing the shells of the same or similar mollusks, plus fish, bird, and mammal bones, ash, and other "domestic" debris (Davis, 2010).

In the northern Gulf of Mexico, the marshes that exist on the bay sides of the barrier islands and their adjacent uplands are nursery areas for a broad range of commercially and recreationally important species of invertebrates and finfish and other profitable organisms, such as the fur-bearing Muskrat. Similarly, the open water areas, bays, tidal channels, and bayous, provide foraging areas and shelter for juveniles and adults of the same and other commercially and recreationally important species, including the American Alligator. As the barrier islands and associated marshes diminish and disappear, the ecosystem for which they provide the habitat diminishes, and the opportunities for the people whose livelihoods depend on that ecosystem also diminish. This diminution also jeopardizes the infrastructure that has been erected to serve another resource use, the petroleum extraction and processing sector. The barrier islands protect many oil and gas wells and their associated transmission, storage, and processing facilities, in, on, and behind the islands. Absent the islands, these wells, pipelines, and facilities would be exposed to the open sea, and the cost of reducing their vulnerability would be considerable. Another aspect of the environment that is jeopardized by the loss of the barrier islands is the estuarine nature of the marshes and bays they protect. The islands provide a physical barrier to salt water intrusion. As the islands reduce in size and the passes between them increase in width, the brackish water interface moves farther up into the bays, resulting in loss of freshwater marsh and swamp forest to open water. Such changes impact those who are dependent on the environment for their livelihood by eliminating or altering the habitat of the organisms they target. Oysters that require an estuarine salinity range for growth and survival do not thrive in an environment that is too fresh or too salty. In a like manner, juvenile fish that both shelter and feed in a vegetated marsh environment will not thrive, or even survive, on a mudflat or in open water.

Because the natural resources of the Louisiana barrier islands and associated wetlands provide such a wide array of products, and their distribution away from the coast involves so many different kinds of commerce, the repercussions of diminishing resources are felt at a national level.

At the present rate of land loss, the disappearance of the five Isles Dernieres has been predicted to occur by TY40 (2052), with the Timbaliers lasting barely beyond TY50 (2062), at which date Timbalier Island is predicted to be only 2 acres of intertidal habitat and East Timbalier only 4 intertidal acres (Table 3-19). The repercussions of the loss will go way beyond disturbance of the above-referenced natural resources and resource-based commercial and recreational activities. The islands, marshes, and wetland forests provide storm protection for the uplands. All of the communities, industrial areas, and transportation infrastructure to the north of the Terrebonne-Barataria Barrier Islands will be placed at risk.

As referenced above, man's activities in the Louisiana barrier island ecosystem have been ongoing since prehistoric times. The social fabric and cultures of the diverse groups of people who inhabit the Louisiana coastal area is so interconnected with the environment that its continuing disturbance and disruption has led to an undercurrent of anxiety within the permanent population, whose extended families have lived in this coastal area for many generations (Gramling and Hagelman, 2005: 132; Laska, et al., 2005).

4.2.15.1 Population and Housing

4.2.15.1.1 Historic Conditions

Detailed historical information for population and housing was not available for the Study Area. Based on review of available literature (e.g., Williams et al. 1992), in the middle of 1800's, Last Island (Isles Dernieres) was a popular vacation resort and had numerous summer cottages and a large hotel. In August 1856, a hurricane completely destroyed the village. The Village of Last Island was never rebuilt. Isles Dernieres and the Timbalier Islands have, for the most part, remained uninhabited by permanent residents since that time.

4.2.15.1.2 Existing Conditions

The Study Area is located in remote and uninhabited coastal wetlands within Terrebonne, and Lafourche Parishes. There are no permanent communities or human populations in the Study Area. The nearest populated areas to the Isle Dernieres and Timbalier Islands are Cocodrie, Port Fourchon and Grand Isle, Louisiana.

4.2.15.2 Employment and Income

4.2.15.2.1 Historic Conditions

The Study Area has remained an uninhabited barrier island since the destruction of Last Island Village by a hurricane in 1856. There have been no communities or human populations residing on the islands; hence, there is no employment or income base. The area has supported sources of income related to oil and gas exploration and production, and commercial and recreational fishing.

4.2.15.2.2 Existing Conditions

The Study Area is located in remote and uninhabited coastal wetlands within Terrebonne and Lafourche Parishes. There are no communities or human populations in the Study Area; hence, there is no employment or income base. The area continues to support sources of income related to oil and gas exploration and production, and commercial and recreational fishing.

4.2.15.3 Community Cohesion

There are no existing communities in the Study Area, therefore community cohesion is not applicable.

4.2.15.4 Environmental Justice

There are no existing communities in the Study Area, therefore environmental justice does not appear to be a concern for this Study.

4.2.15.5 Infrastructure

4.2.15.5.1 Historic Conditions

Louisiana plays an important part in the production of natural gas and crude oil for the Nation. Development of oil and gas resources in the Louisiana coastal zone began in the 1920s and on the outer continental shelf (OCS) in the 1940s. In addition to national importance, oil and gas production has played a significant role in the State's economy (USACE, 2004a).

Since 1921, the oil and gas activities in the coastal zone account for approximately 75% of all State lands leased. As these activities increased in Louisiana, the transportation and storage of these natural resources required new infrastructure, including pipelines for distribution from nearshore wells, to railroad facilities for transport to processing plants. With the advent of offshore drilling, pipelines were constructed to connect offshore oil and gas production platforms with onshore facilities. Today, these pipeline systems extend all across coastal Louisiana in a labyrinth consisting of nearly ten thousand miles of pipeline (USACE, 2004b).

4.2.15.5.2 Existing Conditions

As with most of the barrier islands in coastal Louisiana, the Isles Dernieres and Timbalier Islands are unpopulated landmasses. Though some barrier islands do contain semi-permanent populations, e.g. fishing camps and hamlets, (USDI, 2004), Grand Isle is the only developed barrier island in Louisiana (population of 1,541; 2000 census data) (LAGIC, 2007).The Study Area continues to support oil and gas infrastructure on the eastern end of the Isles Dernieres and majority of the Timbalier Islands.

4.2.15.6 Business and Industry

The primary types of business and industry in the Study Area are petroleum exploration, production, and transportation; commercial fishing, and recreational fishing.

4.2.15.7 Traffic and Transportation

4.2.15.7.1 Historic Conditions

No transportation infrastructure has historically existed in the Study Area. Historically, transportation to the barrier islands has been by boat.

4.2.15.7.2 Existing Conditions

Given their disconnection from the mainland, and the lack of permanent residents, no permanent ground transportation infrastructure exists on the Terrebonne Basin barrier island chain. With no surface roads or railroads, and with only a few small access canals on Trinity, Timbalier, and East Timbalier Islands, transportation to and on the Terrebonne Basin barrier islands is limited. Transportation to the islands is possible by boat or floatplane, while transportation on the islands is limited to all-terrain vehicles, which are typically utilized for recreational purposes (USEPA, 2000).

4.2.15.8 Public Facilities and Services

4.2.15.8.1 Historic Conditions

Public facilities and services were not available in the Study Area.

4.2.15.8.2 Existing Conditions

No significant public facilities or services are provided within the Study Area. The Terrebonne Basin barrier island chain falls entirely or partially within two conservation areas; the State-managed Isle Dernieres Barrier Islands Refuge (BIR) and the BTES. Except for a portion of Trinity Island, access to the islands within the BIR is restricted to surf fishing within the tidal zone (Mike Carloss, personal communication, August, 2008).

4.2.15.9 Local Government Finance

The Study Area is located in remote and uninhabited coastal wetlands within Terrebonne and Lafourche Parishes. Local government finance is not applicable to this Study.

4.2.15.10 Tax Revenue and Property Values

4.2.15.10.1 Historic Conditions

The Study Area is located in remote and uninhabited coastal wetlands within Terrebonne and Lafourche Parishes. Tax revenue and property values are not applicable to this Study.

4.2.15.10.2 Existing Conditions

The Study Area is located in remote and uninhabited coastal wetlands within Terrebonne and Lafourche Parishes. There are no communities or human populations in the Study Area; hence, there are no taxable revenues or income base. The area may support sources of income related to oil and gas exploration and production, and commercial and recreational fishing. Whiskey, Trinity, East, and Raccoon Islands are wholly owned by the State of Louisiana. Timbalier and East Timbalier Islands are privately owned and subject to property taxes. Gross appraisals were not performed on Timbalier and East Timbalier, however, estimated property values for these areas are approximately $500/acre.

4.2.15.11 Community and Regional Growth

4.2.15.11.1 Historic Conditions

Population densities have historically been highest in the central and northern parts of the parish, and lowest in the southern reaches. The few isolated communities that have developed near the GOM are typically service communities for the oil and gas industry, or support recreational and commercial fishing interests (USEPA, 1993).

4.2.15.11.2 Existing Conditions

In Louisiana, the Mississippi River was historically the primary means of transportation, and its natural levees were the choice location for settlement. Over time, the surrounding coastal lakes and adjacent lands were gradually explored for natural resources and settlement. As the population along the Mississippi River increased, land along its natural levees became scarce. Settlers began to move further outward following waterways such as Bayou Lafourche, Bayou Teche, Bayou Terrebonne, the Vermilion River, and other bayous and rivers in the coastal area (USACE, 2004b). Similar trends were observed in Terrebonne Parish, where migration and population concentrations occurred along waterways and adjacent natural levees.

4.2.15.12 Land Use Socioeconomics

4.2.15.12.1 Agriculture

Historic Conditions

There are no historic agriculture uses within the Study Area.

Existing Conditions

There is no agricultural use within the Study Area.

4.2.15.12.2 Forestry

Historic Conditions

Historical information regarding forestry practices within the Study Area has not been found during the due diligence investigations.

Existing Conditions

There is no forestry practice conducted within the Study Area.

4.2.15.12.3 Public Lands

Historic Conditions

This resource is institutionally significantly because of the Federal Water Protection Recreation Act of 1965, as amended; the Land and Water Conservation Fund Act of 1965, as amended; the National Wildlife Refuge System Administration Act of 1966; and the National Wildlife Refuge System Improvement Act of 1997. Public lands are technically significant because of the high economic value of recreational activities and their contribution to local, state, and national economies. Public lands are publicly significant because of the high value that the public places on conservation of natural resources, as well as access for fishing, hunting, and boating activities, as measured by the large number of fishing and hunting licenses sold in Louisiana, and the large per-capita number of recreational boat registrations in Louisiana.

Public lands are those that are owned by the Federal or State government, which have been made available for public access. The National Wildlife Refuge System Improvement Act of 1997 authorized that no new or expanded use of a refuge may be allowed unless it is first determined to be a compatible use and the use is not inconsistent with public safety.

Existing Conditions

Terrebonne Barrier Islands Refuge (BIR) consists of three barrier islands in the Isles Dernieres reach. Wine Island, Whiskey Island, and Raccoon Island were acquired in June of 1992 from Louisiana Land and Exploration Company via a 25-year free lease. The three islands comprise a total of approximately 630 acres, although the lease agreement covers several thousand acres of water.

Except for a portion of Trinity Island, access to the islands within the BIR is restricted to surf fishing within the tidal zone (Mike Carlos LDWF, personal communication, August, 2008).

The reach of islands that comprise the Isles Dernieres serves as permanent and migratory stopover habitat for shorebirds and passerine species (USEPA, 1997a). Of the numerous waterbird nesting colonies within the Terrebonne Basin barrier islands complex, the most significant are those found within the BIR. Raccoon Island, which supports one of the greatest diversities of nesting and aquatic birds in North America, contains one of the largest nesting colonies of endangered Pelecanus occidentalis (brown pelicans) in Louisiana and a significant colony of piping plovers (129 identified during winter census; Louisiana Coastal Wetlands Conservation and Restoration Task Force, 2006). Just a short distance to the east, Whiskey Island contains some black skimmer nesting, but otherwise receives little bird usage (USEPA, 1997a).

Management of Wine Island, on the eastern end of the Isle Dernieres reach, was successfully reestablished in 1991 by the Louisiana Department of Natural Resources. Bird activity on the islands is monitored by Fur and Refuge Division staff from the Atchafalaya Delta, New Iberia, and Rockefeller Refuge. Enforcement of rules and regulations is provided by personnel stationed at the Atchafalaya Delta WMA.

4.2.15.13 Water Use and Supply

4.2.15.13.1 Historic Conditions

There were no historic sources of fresh water in the Study Area. Historic water use was limited to personal consumption. Water was either transported to the Study Area or obtained by capturing rainwater onsite with cisterns.

4.2.15.13.2 Existing Conditions

There are no onsite sources of fresh water in the Study Area. Supplies of potable water are either transported to the Study Area or obtained by capturing rain water onsite with cisterns.

4.2.15.14 Navigation

4.2.15.14.1 Historic Conditions

Historically as well as present, the ports and shipping lanes of coastal Louisiana serve as vital linkages between producers and consumers throughout the Nation, and as gateways for international trade. The navigation channels and waterways provide for large-scale waterborne transportation of both commodities and finished products, and an extensive network of oil and gas canals and infrastructure.

4.2.15.14.2 Existing Conditions

Within the Terrebonne Basin there is one federally maintained navigation feature that is important to barrier island morphology, restoration, and maintenance. This canal, the Houma Navigation Canal (HNC), serves as a navigation route connecting the GOM with the interior of the central coast of Louisiana, providing direct access to the maritime and offshore support interests. The HNC cuts through and provides pathways to several natural waterways including Bayous Black, La Carpe, du Large, Petit and Grand Caillou, Sale, and Little Cocodrie Bayou, most of which discharge into Terrebonne Bay north of the Isles Dernieres (USACE, 2005).

These navigation channels introduce and/or compound marine influences in many of the interior wetlands and water bodies within the coastal zone (USACE, 2004a). The HNC has direct influence on the Terrebonne Basin barrier shoreline as its mouth is situated in Cat Island Pass at the western end of Timbalier Island. Periodic maintenance dredging of the HNC also provides an opportunity for the beneficial use of dredged material on Timbalier Island and Isles Dernieres. However, because of the close proximity of the canal to the western end of Timbalier Island, consideration must be given to ensure that the canal dredging does not adversely impact the westerly longshore transport of sand. Since the islands support limited recreational, commercial, and industrial usages, few privately maintained channels and passes exist.

The thousands of miles of navigation channels and oil and gas canals in coastal Louisiana have played a major role in the loss of wetlands and barrier islands (USACE, 2004a). These losses can be attributed to the direct conversion of marsh to open water, as well as by the indirect impacts associated with altered hydrology and saltwater intrusion. The existing and newly constructed oil and gas canals and the maintenance of navigation channels will continue to facilitate saltwater intrusion into interior coastal wetlands. Salinity gradients across the coast will migrate north and become more narrow and variable without additional inputs of freshwater from riverine sources to hold back Gulf waters. Additionally, navigation channels that cross open bays may silt in more rapidly or begin to shoal in less predictable ways. Without barrier island restoration, the islands and marshes that protect waterborne traffic will continue to erode and adversely impact vital navigable waterways. As the adjacent and connecting protective marsh and barrier island landscapes disappear, the wind, and wave energy from nearby open bays and the GOM will have increased adverse effects on these navigable waterways (USACE, 2004a).

4.2.15.15 Man-Made Resources

4.2.15.15.1 Oil, Gas, Utilities, Pipelines

Louisiana plays an important part in the production of crude oil for the Nation. Louisiana's production of crude oil has declined by about 30% since 1980, although production in the Louisiana offshore Outer Continental Shelf (OCS) has increased steadily since 1990 and now exceeds the onshore production rate (MMS, 1999). In 2000, Louisiana produced more crude oil than any other state. Louisiana's oil resources come from wells on land, from State waters within three miles from shore, and from Federal waters greater than three miles from shore. The amount of oil produced by Louisiana can be put into perspective by comparing it to what is consumed by the entire Nation. Energy consumption can be divided into five sectors: transportation, industrial, electric power generation, residential, and commercial. Over the past 20 years, Louisiana crude oil production alone has been greater than what has been consumed nationally in three of these sectors: residential, commercial, and electric power generation. Louisiana production has increased in the past ten years so that in 2000 it produced enough crude oil to meet the needs of all three of these sectors. Louisiana provides over 27% of the total oil produced in the U.S. If Louisiana did not produce oil, the U.S. would have to import 30% more oil from the Organization of the Petroleum Exporting Countries (OPEC) than it currently does. Any significant decrease in Louisiana production would affect citizens in all states.

Natural gas has been the second largest source of energy for the U.S. since 1988. The United States had large natural gas reserves until the late 1980s when consumption began to significantly outpace production. Three states (Texas, Louisiana, Oklahoma) account for over half of all natural gas produced in the U.S. The amount of natural gas produced by Louisiana can be put into perspective by comparing it to what is consumed by the entire Nation in five economic sectors. Over the past 20 years, Louisiana, gas production has been greater than what has been consumed in four of the five sectors: transportation, commercial, electric power, and residential sectors. Louisiana currently provides over 26% of the total natural gas produced in the U.S. Over the past 20 years, Louisiana has produced more natural gas than was imported by the Nation. If Louisiana did not produce natural gas at the same level of consumption, the U.S. would have to import 133% more gas from other countries than it currently does. Any significant decrease in Louisiana's natural gas production would have a significant impact on the U.S. economy.

All of the oil and gas produced along Louisiana's coast and wetlands comes from a highly interdependent network of core and supporting industries. The core businesses, along with their suppliers, contractors, services and research departments, sprung up around each other and formed a huge cluster of business linked to each other and to other industries throughout the region. Port Fourchon is the geographic and economic hub of this cluster. There are hundreds of offshore drilling rigs in the Gulf of Mexico.

The Study Area is traversed by numerous oil and gas pipelines of various sizes, many within the footprints of the plan alternatives and in their immediate vicinity (Figures 4-14 through 4-16).

The lines represent both a substantial investment and a substantial level of risk for the area. The pipelines are increasingly at risk from a combination of coastal erosion and local navigation. The erosion of wetland areas uncovers pipelines that had been buried in the marsh for protection. As land is converted to open water, the pipelines remain under water and unprotected from maritime traffic. Boat collisions with the underwater pipes result in substantial losses for the industry since collisions sometimes cause spills. With each spill, production is impacted at both ends of the pipeline system—where oil is loaded, and where it is unloaded. In addition, cleanup costs can be substantial.

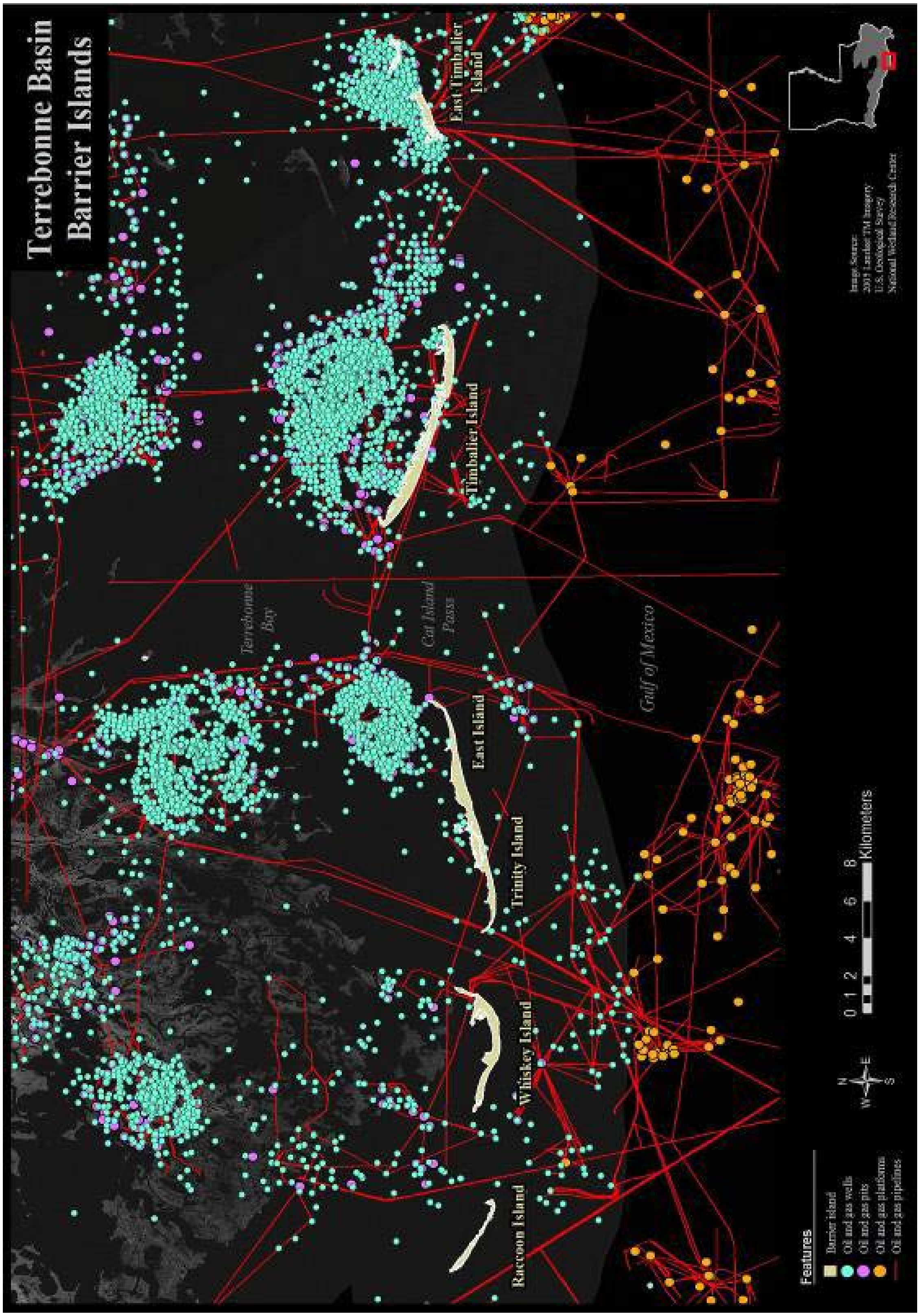

Figure 4-14. Oil and Gas Structures and Pipelines within the Terrebonne Basin

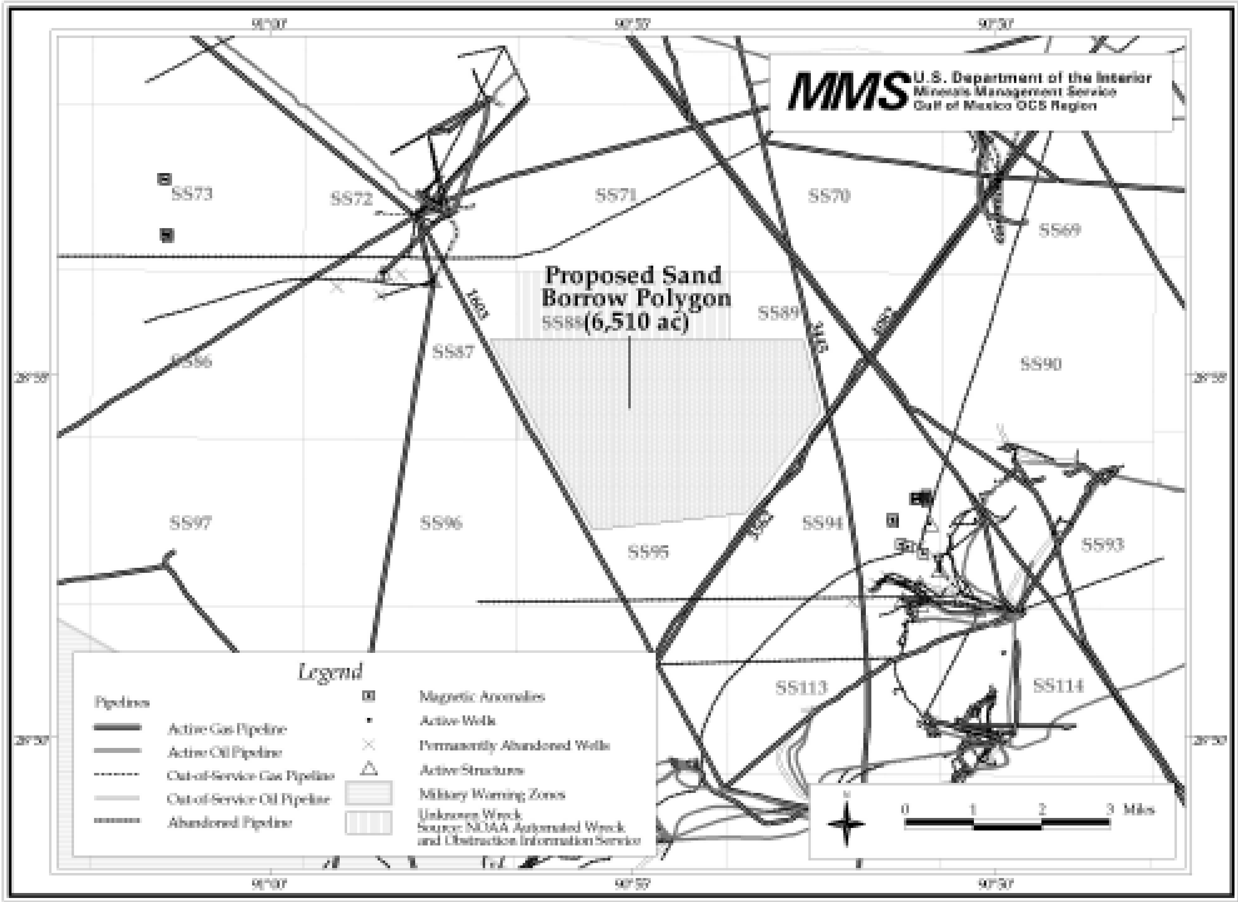

Figure 4-15. Potential Ship Shoal sand borrow areas and OCS infrastructure (MMS 2004)

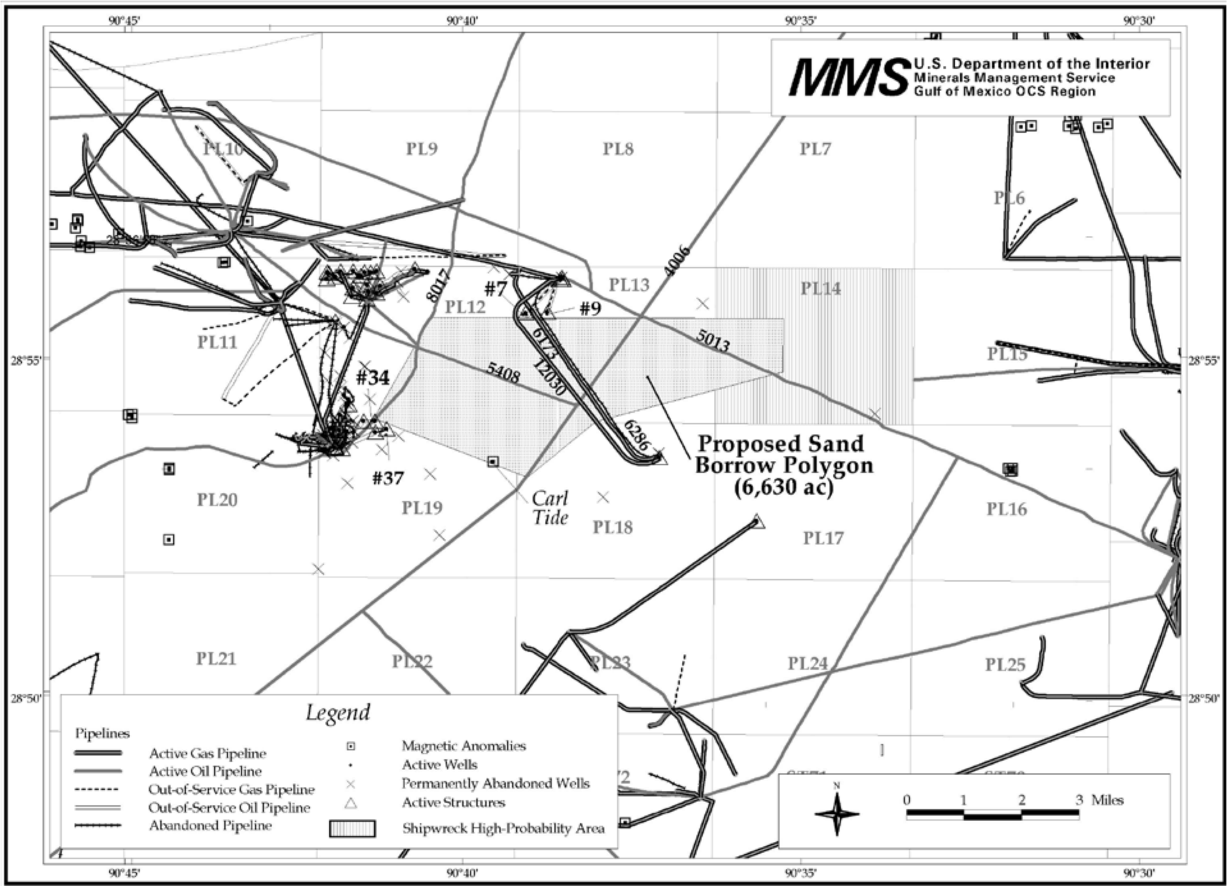

Figure 4-16. The proposed South Pelto sand borrow area and OCS infrastructure (MMS 2004)

4.2.15.15.2 Flood Control and Hurricane Protection

Historic Conditions

No flood control or hurricane protection features have historically existed in the Study Area.

Existing Conditions

The Study Area does not contain any flood control or hurricane protection structures. The closest flood control or hurricane protection measure is located in Chauvin, Louisiana.

4.2.15.16 Natural Resources

4.2.15.16.1 Commercial Fisheries

Historic Conditions

Louisiana has five main commercial fishing ports located on main waterway arteries leading from the GOM. These ports are located in: 1) Empire-Venice area along the Mississippi River with main access to the Gulf through the Empire Waterway and Tiger Pass; 2) Dulac-Chauvin area in Terrebonne Parish with main access to the Gulf through the Houma Navigation Canal; 3) Morgan City-Berwick area along the Atchafalaya River; 4) Intracoastal City on the west side of Vermillion Bay; and 5) Cameron in southwest Louisiana along the Calcasieu River. The seafood industry in south Louisiana is based primarily on the harvesting of white and brown shrimp, crabs, oysters, and menhaden.

In terms of dockside revenue, the shrimp is the most important commercially landed marine species in Louisiana. Since 1976, shrimp landings in Louisiana have ranged from a low of approximately 49 million pounds (heads-off weight) in 1983, to a high of approximately 93 million pounds in 1986. In 2006, the total weight (heads-on) of shrimp landed in Louisiana was approximately 137 million pounds, had a value of more than $147 million, and accounted for more than 47% of the United States' total (LDWF, 2008c).

Existing Conditions

Louisiana produced about 52.8 million pounds of blue crabs, totaling $31.8 million in dockside revenue, and accounting for 36% of the Nation's total production for 2006 (LDWF, 2008c). Since 1976, Louisiana has experienced significant increases in blue crab landings. These landings, which have ranged from a low of approximately 15 million pounds in 1973, to a high of approximately 52 million pounds in 2006, have resulted in Louisiana becoming one of the largest producers of blue crabs in the Nation (LDWF, 2008c). These trends in blue crab landings have allowed Louisiana to surpass the dominant producing states of the 1990s (USACE, 2004b).

Landings of most fish species are expected to vary somewhat from year to year depending on naturally varying environmental conditions. One of the most important species harvested in the Louisiana waters is the Gulf menhaden. This species of fish is primarily processed for both fishmeal and fish oil. Fishmeal is used as a high protein animal feed. The broiler (chicken) industry is currently the largest user of menhaden meal, followed by the turkey, swine, pet food, and ruminant (cattle/livestock) industries. The 2006 Louisiana menhaden fisheries landings were the largest in the Nation (746 million pounds; LDWF, 2008c), landing twice as much as the next closest state. The percent of dockside value from Louisiana to that of the rest of the Nation was over 57% (USACE, 2004b).

Louisiana also has led the United States in eastern oyster production, contributing just under half of the U.S. production. In 2006 alone, Louisiana had 58% of the Nation's eastern oyster landings (approximately 11.5 million pounds; LDWF, 2008c), and 49% (approximately $36 million; LDWF, 2008c) of the Nation's eastern oysters dockside value (USACE, 2004b).

Located just north of the Study Area, the port at Dulac-Chauvin, Louisiana, reported commercial fisheries landings in 2007 at 23.5 million pounds with a dockside value of 35.5 million dollars (NMFS, 2008).

Commercial landings (dockside value) of fish and shellfish, including freshwater fish, in Louisiana are presented in Figure 4-17 (source: (LDWF, 2008). Fluctuations in year to year landings can be caused by a variety of factors including winter freezes, drought, tropical storms, and transportation costs, and usually do not indicate long-term environmental problems. Individual organisms produce large numbers of eggs, so populations can recover quickly from short-term detrimental conditions. However, long-term (3 years or more) declines in landings can signify that there are ongoing environmental problems and/or over-fishing of the resource, or a weakening market. The main environmental problem would be the disappearance of estuarine marsh nursery areas. Remaining areas can not support as many young. Table 4-12 contains the marine commercial landings data for 2006 provided by the LDWF, divided into individual species of shellfish and finfish (LDWF, 2008).

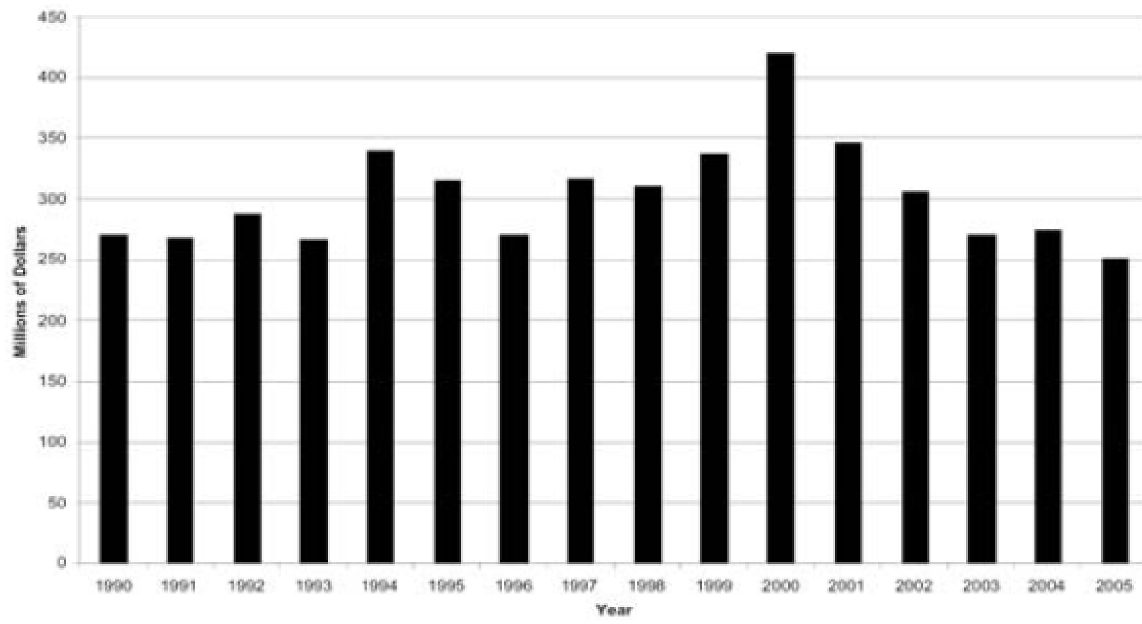

Figure 4-17. Marine Commercial Landings Dockside Value Louisiana 1990-2005. (LDWF, 2008)

Table 4-12. 2006 Marine Commercial Landings. (LDWF, 2008)

Species	*Landings (lbs)*	*Value ($)*
Crab	52,926,644	$31,999,624
Freshwater Fish	11,719,263	$4,519,433
Menhaden	746,492,760	$29,781,088
Oyster	11,482,506	$36,166,218
Saltwater Fish	12,925,060	$19,718,268
Shrimp	137,845,520	$147,703,719
Wild Crawfish	1,467,577	$1,289,429

4.2.15.16.2 Oyster Leases

Historic Conditions

In 1892, Louisiana Act 206 established the first public oyster grounds open to all Louisiana residents. Act 206 also adjusted the closed season, increased the size of a lease to ten acres (4 ha), and authorized the office of oyster inspector to enforce the laws. Ten years later, Louisiana's first comprehensive oyster law was passed with the Act of 1902. The Louisiana Department of Conservation issued the first private oyster lease in 1903 in Plaquemines Parish (Laiche, 1993). Additionally, the State manages several oyster seed grounds, from which oysters can be collected for transfer to private leases.

Oysters have been harvested in Louisiana for commercial sale for at least 150 years. The Louisiana oyster industry has been experiencing many stressors over the past several decades that threaten the long-term sustainability of both the industry and the resource. Increasing coastal land loss is reducing the amount of marsh that provides shelter to oyster reefs, and saltwater intrusion is exacerbating disease and predation. In addition, the industry is faced with changing environmental conditions, fluctuating market demands, public perception issues, and increased competition.

Oyster lease acreage in Terrebonne Parish steadily increased between 1959-60 and 2002 and then exhibited minor decreases to 2005. Lafourche Parish oyster lease acreage steadily increased between 1959-60 to 2001 and has steadily decreased to 2005.

Existing Conditions

Terrebonne and Lafourche parish play an important role in Louisiana's oyster industry, accounting for more than 25% of the State's total oyster leases (by area; Table 4-13). Within 6 kilometers of the Study Area, there are approximately 100 oyster leases. These leases are most plentiful to the north of the Isles Dernieres reach, in the northern portions of Caillou Bay and Lake Pelto. Locations of oyster leases in the Study Area are shown on Figure 4-11 in section 4.2.9.2. Though there are many leases in the Isles Dernieres vicinity, few leases are located near the Timbalier Island Reach. Nearby seed grounds are managed by the LDWF to produce a ready supply of seed oysters that can be planted on private leases for later harvest. The oyster lease acreage in Terrebonne and Lafourche Parishes is presented in Table 4-13. Oyster leases have been a serious constraint on conducting coastal restoration since the beginning of early coastal restoration efforts in the 1990's.

The Gulf region led the U.S. in oyster production in 2007 with 22 million pounds of meats, 63% of the national total (NMFS, 2008). In Louisiana, a total of 12.8 million pounds of oyster were harvested in 2007, with a value of $40.1 million (NMFS, 2008). Production of oysters in Louisiana has been relatively stable for the last 50 years, with harvest from public beds replacing the decreasing harvest from private leases. However, increasing coastal land loss is reducing the amount of marsh that provides shelter to reefs, and saltwater intrusion is exacerbating disease and predation.

Oysters have been harvested in Louisiana for commercial sale for at least 150 years and provide an important resource in the Terrebonne Basin. Oyster leases have been a serious constraint on conducting coastal restoration since the beginning of early coastal restoration efforts in the 1990's (USACE, 2009). Natural coastal processes will at times migrate island footprints over or near existing oyster leases. For the longevity of the restoration to reach the Study goals the design template may be enlarged and therefore encompass existing oyster leases. The proximity of the oyster leases to the construction activities should always be considered during a restoration projects such that the sediment plumes from dredging and dewatering do not adversely affect the health of the oysters. Typically oyster leases that could be affected by such activities would be mitigated following the design of the restoration project. The oyster lease acreage in Terrebonne and Lafourche Parishes is presented in Table 4-13.

Table 4-13. Oyster lease acreage in Terrebonne and Lafourche Parishes. (source: http://oysterweb.dnr.state.la.us/oyster/oystertable.htm)

Year	Terrebonne Parish		Lafourche Parish		Louisiana Total	
	Acres	Average change per year	Acres	Average change per year	Acres	Average change per year
1959-60	19,127		5,827		73,591	
1969-70	22,539	(+) 341.2	11,535	(+) 570.8	138,837	(+) 6,524.6
1975-76	33,012	(+) 1,745.5	12,951	(+) 236.0	193,225	(+) 9,064.7
1976-77	38,781	(+) 5,769.0	15,157	(+) 2,206.0	213,411	(+) 20,186.0
1977-78	44,762	(+) 5,981.0	17,340	(+) 2,183.0	231,909	(+) 18,498.0
1978-79	43,284	(-) 1,478.0	18,456	(+) 1,116.0	237,946	(+) 6,037.0
1979-80	41,265	(-) 2,019.0	15,689	(-) 2,767.0	228,960	(-) 8,986.0
1980-81	42,595	(+) 1,330.0	15,657	(-) 32.0	231,762	(+) 2,802.0
1981-82	43,025	(+) 430.0	15,119	(-) 538.0	236,331	(+) 4,569.0
1988-89	51,813	(+) 1,255.4	16,930	(+) 258.7	328,269	(+) 13,134.0
1990-91	53,530	(+) 858.5	18,870	(+) 970.0	345,394	(+) 8,562.5
1991-92	55,033	(+) 1,503.0	17,851	(-) 1,019.0	356,711	(+) 11,317.0
1992	61,331	(+) 6,298.0	17,528	(-) 323.0	359,902	(+) 3,191.0
1997	81,664	(+) 4,066.6	21,158	(+) 726.0	378,747	(+) 3,769.0
1998	89,247	(+) 7,583.0	21,951	(+) 793.0	397,916	(+) 19,169.0
1999	88,886	(-) 361.0	22,356	(+) 405.0	403,141	(+) 5,225.0
2000	92,385	(+) 3,499.0	26,277	(+) 3,921.0	415,459	(+) 12,318.0
2001	93,661	(+) 1,276.0	27,402	(+) 1,175.0	419,900	(+) 4,441.0
2002	93,858	(+) 197.0	26,228	(-) 1,174.0	419,091	(-) 809.0
2003	92,711	(-) 1,147.0	24,891	(-) 1,337.0	409,209	(-) 9,882.0
2004	92,548	(-) 163.0	24,802	(-) 89.0	397,892	(-) 11,317.0
2005	92,023	(-) 525.0	23,706	(-) 1,096.0	392,763	(-) 5,129.0
2006	91,890	(-) 133.0	23,448	(-) 258.0	392,118	(-) 645.0

Oyster lease acreage in Terrebonne Parish steadily increased from 1959 to 1978. The Parish experienced a decrease from 1979 to 1980 followed by a relatively steady increase until 2003. Following 2003, Terrebonne Parish begins to have a decline in acreage each year.

Oyster lease acreage in Lafourche Parish steadily increased from 1959 to 1979. From 1980 to 1997 the oyster lease acreages fluctuate at which time Lafourche

Parish experiences increasing levels until 2002. This growth slows and by 2002 begins to decline in acreage each year.

In comparison to Terrebonne and Lafourche Parish, the overall acreages for the State continually increase from 1959 to 2001 except for the 1979-80 season. Following 2001 the oyster lease acreage totals begin to decline with a sharp decrease in 2004.

4.2.16 Hazardous, Toxic, and Radioactive Wastes

A Phase I Environmental Site Assessment of the Study Area was conducted and recorded in *HTRW Phase I Environmental Site Assessment, Terrebonne Basin Barrier Shoreline Restoration Project, Contract No. 2503-07-15* for Coastal Protection and Restoration Authority.

The purpose of this Phase I ESA is to identify historical or overt physical evidence of current or past activities or materials at the Site and its immediate vicinity which constitute "recognized environmental conditions,"(RECs) defined by the ASTM Standard to be "the presence or likely presence of any hazardous, toxic, and radioactive substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release… into structures on the property or into the ground, groundwater, or surface water of the property."

This Phase I ESA is consistent with the Scope of Work (SOW) provided by the Corps of Engineers and protocols established in the American Society for Testing and Materials publication "Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process for Forestland or Rural Property" (Designation E 2247-08, referred to as the ASTM Standard) to provide "due diligence" for rural transactions. However, this report will require a second site visit and interviews related to ASTM Standard to be conducted at a later date that is closer to expected time of construction for the year 2012.

On November 20, 2008, SJB's environmental specialists performed an aerial site reconnaissance of the subject property and its adjacent properties and a field visit on July 27-30th, 2009 at selected locations throughout the Study Area. The Site is currently Terrebonne Basin Barrier Shoreline consisting of seven major barrier islands that include: East Timbalier Island, Timbalier Island, Wine Island, East Island, Trinity Island, Whiskey Island, and Raccoon Island. Photographs were taken documenting field observations and are included in this report.

SJB obtained historical documentation of the Site's past uses and activities in order to identify possible recognized environmental conditions. Sources of historical documentation for this report included historical aerial photographs, topographic maps, and Environmental Database Report.

SJB has performed a Phase I Environmental Site Assessment on Isle Dernieres and the Timbalier Island reach, located within Terrebonne Basin in Terrebonne Parish, Louisiana (the Site). Any exceptions to or deletions from this practice are described in section 2.4 of this report. Based upon historical sources, environmental database reviews, and a limited Site inspection, at this time SJB did not identify any current Recognized Environmental Conditions, or any historical Recognized Environmental Conditions that would affect the proposed project. The Emergency Response Notification System (ERNS) records six spills (see appendix) of petroleum products in the Study Area. These incidents are historical Recognized Environmental Conditions (RECs), but would not affect the proposed project.

There are numerous oil and gas production facilities and pipelines in the Study Area; these are the most likely locations where Recognized Environmental Conditions might be found. Because of the large number of wells and pipelines in the area a site visit to each would be impracticable; however, the area has been physically surveyed by water and air, and relevant databases have been consulted. No Recognized Environmental Conditions were found, but these wells and pipelines deserve continuing vigilance, both up to and during construction.

Based on historical sources that were provided dating back to the late 1800's, environmental database reviews, and a limited Site inspection, SJB can not adequately identify any current and historical recognized environmental conditions as defined in ASTM standard E 2247-08 at this time. A more in depth site visit and interviews with people knowledgeable of the Site history will be conducted closer to the expected construction time.

5.0 ENVIRONMENTAL CONSEQUENCES

This chapter describes the potential environmental consequences of implementing alternative plans considered for restoration of the Terrebonne Basin Barrier Shoreline. The prefatory description of the importance of the barrier islands to the ecological and socioeconomic fabric of Louisiana that is contained in §4.2.15 is equally relevant and pertinent to the discussion of the Environmental Consequences of the restoration of the Terrebonne Basin Barrier Shoreline. One must be cognizant of the complex of interrelationships involving the living and mineral natural resources of coastal Louisiana, the changing geographic morphology of the region, and the people who depend on the area for their livelihood. This awareness should be in the forefront as one studies the following analysis, which compares the No Action Alternative (Future Without Project Conditions) to five alternatives carried over from the final array.

Alternative 2: Timbalier (Plan E)

Alternative 3: Whiskey (Plan C)/Timbalier (Plan E)

Alternative 4: Whiskey (Plan C)/Trinity (Plan C)/Timbalier (Plan E)

Alternative 5 (NER Plan): Raccoon with TG (Plan E)/Whiskey (Plan C)/Trinity (Plan C)/Timbalier (Plan E)

Alternative 11: Whiskey (Plan C with renourishment)

These alternatives were carried forward for detailed analysis because they were all cost effective and fell along the efficient frontier curve. Alternatives 6, 7, 8, 9, and 10 were not cost effective and therefore, not carried forward for further analysis. Alternative 9 was also removed from further analysis because the cost per AAHU was significantly (14%) higher than Alternative 2 and it fell above the efficient frontier curve.

The first component of construction was developed by considering the best combination of restoration plans that would meet the study objectives. All restoration alternatives considered during the alternative plan formulation process are described in more detail in Section 3.3.

The environmental analysis includes comparison of the potential direct, indirect, and cumulative impacts. Direct impacts are those effects that are caused by the action and occur at the same time and place (40 CFR 1508.8(a)). For example, unavoidable effects on fish and wildlife from the placement of dredged material to restore/create barrier shoreline. Indirect impacts are those effects that are caused by the action and are later in time or further removed in distance, but are still reasonably foreseeable (40 CFR 1508.8(b)). For example, the reduction in hurricane storm surge that indirectly results from restoration/creation of the barrier system of shorelines, headlands, and islands and salt marsh. Cumulative impacts are the effects on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from actions that individually are minor, but collectively result in significant actions taking place over time (40 CFR 1508.7). For example, the incremental impacts of barrier island restoration at several areas throughout the basin, could, collectively, significantly modify an entire basin's barrier system. The cumulative impact analysis followed the 11-step process described in the 1997 report by the Council of Environmental Quality entitled "Considering Cumulative Effects Under the National Environmental Policy Act."

Table 5-1. Comparison of Cumulative Impacts*

SIGNIFICANT RESOURCE	Past Actions (Historic Conditions)	Present Action (Existing Conditions)	Future Without-Project The No Action Alternative	Cumulative Impacts (Comparison of Future With Proposed Action Impacts for each Restoration Alternative and the NER)
Soil Resources	US, LA & SA: Natural processes of parent material, climate, organisms, relief, time, waves, runoff, and other factors in soil formation and soil loss. Institutional recognition of importance of soil resources with formation of Soil Conservation Service, later to become Natural Resources Conservation Service. Upstream dams, locks, and reservoirs, become sinks for sediments carried by Mississippi River. Leveeing Mississippi River and tributaries eliminates seasonal overflows of sediment-laden waters responsible for soil building in deltaic plain.	US: Continued institutional recognition. Human activities (population growth, agriculture, industry, etc.) continue impacting natural processes of soil formation and soil loss. Soil conservation measures and construction of levees, dams, locks, and other structures reduces sediment loads in Mississippi River and tributaries. LA: Louisiana coastal land loss of over 1,900 square miles (492,097 ha) since the 1930s. Total of about 6,337 acres (2,564 ha) barrier habitat restored with beneficial use of dredged material (746 acres [302 ha]) and CWPPRA restoration projects (5,591 acres [2,262 ha]). SA: LCA TBBSR Study Area is currently losing soil resources at a mean rate of 57 ft/yr.	US: Continued institutional recognition. Continued human activities and resultant degradation and loss of soil resources. LA: Continued coastal land loss with prediction of 328,000 acres (13,284 ha) lost over the next 50 years. SA: Continued barrier island habitat loss with 3,227 acres of soil resources from all seven islands predicted to be lost over next 50 years, leaving only 6 acres of intertidal habitat at two islands beyond TY50.	US: Continued institutional recognition. Continued degradation and loss of soil resources. Continued technical assistance and cost-sharing programs for soil conservation to reduce soil losses. LA: Without a comprehensive coast wide coastal restoration effort, coastal land loss would continue with prediction of nearly 328,000 acres (13,284 ha) loss over the entire Louisiana coastal area by 2050. Implementing the NER PLAN with renourishment would result in a modest increase of soil resources. A5 (NER Plan)*:* restore net total of 2,760 acres barrier soil resources. A11*:* restore net total of 527 acres barrier soil resources. A2*:* restore net total of 1,311 acres barrier soil resources. A3*:* restore net total of 1,838 acres barrier soil resources. A4: restore net total of 2,119 acres barrier soil resources.

**Cumulative impact analysis follows the 11-step process described in the 1997 report by the Council of Environmental Quality entitled "Considering Cumulative Effects Under the National Environmental Policy Act." Includes Spatial/Geographic Extent (Continental United States [US], Louisiana [LA}, and Study Area [SA]; and Temporal (Past, Present, and Future Without-Project). Identifier Code: A2, A3, A4, A5, and A11= Terrebonne Basin Barrier Island Restoration (TBBSR) Feature 2, 3, 4, 5 and 11 respectively; NER = National Ecosystem Restoration Plan.*

SIGNIFICANT RESOURCE	Past Actions (Historic Conditions)	Present Action (Existing Conditions)	Future Without-Project The No Action Alternative	Cumulative Impacts (Comparison of Future With Proposed Action Impacts for each Restoration Alternative and the NER)
Offshore, Nearshore, and Riverine Sand Resources	US, LA & SA: Natural processes of longshore transport, erosion, tides, etc., build and deplete offshore sand deposits. Institutional recognition of importance of resources with creation of MMS.	US & LA: Continued institutional recognition. MMS establishes Louisiana Sand Management Working Group to better manage offshore sand resources. Natural processes and human activities continue to build and deplete sand deposits. SA: Continued oil, gas, and mineral exploration and extraction activities on Ship Shoal and other offshore and nearshore sand resource areas. Nearshore and riverine sand resources continued to be utilized for fill in construction and civil works projects.	US & LA: Continued institutional recognition. Natural processes and human activities continue to build and deplete offshore sand deposits. Increased competition for offshore and nearshore areas especially for oil and gas exploration. SA: Large areas of the offshore sand shoals (Ship Shoal) and nearshore sand bodies would likely continue to remain largely undisturbed from dredging or other mining efforts, except for oil and gas exploration and extraction activities. Continue to utilize riverine sand resources for fill in construction and civil works projects. Upstream soil conservation practices would likely continue resulting in decrease of available sediments to replenish sediment borrow sites.	US & LA: Continued institutional recognition. Natural processes and human activities continue to build and deplete offshore sand deposits. Increased competition for offshore areas especially for oil and gas exploration. Continue to utilize riverine sand resources for fill in construction and civil works projects. Upstream soil conservation practices would likely continue resulting in decrease of available sediments to replenish sediment borrow sites. Implementing the NER Plan would result in a comparatively small reduction to offshore sand resources. A5 (NER Plan): removal of 79,427,267 CY of borrow material. A11: removal of 26,940,249 CY of borrow material. A2: removal of 24,027,311 CY of borrow material. A3: removal of 50,967,560 CY of borrow material. A4: removal of 65,623,620 CY of borrow material.

SIGNIFICANT RESOURCE	Past Actions (Historic Conditions)	Present Action (Existing Conditions)	Future Without-Project The No Action Alternative	Cumulative Impacts (Comparison of Future With Proposed Action Impacts for each Restoration Alternative and the NER)
Barrier Systems: Barrier Shorelines, Headlands, and Islands	US & LA: Barrier systems naturally build and erode dependent on deltaic cycle and other geomorphic processes. Institutional recognition (Coastal Barrier Resources Act of 1990). Increased flood control (especially leveeing) of Mississippi River and tributaries following 1927 regional flooding further disrupts deltaic cycle and barrier system building in coastal Louisiana. SA: Construction of navigation channels, jetties, oil and gas exploration and access canals, and other structures along gulf shoreline alters longshore transport and sediment availability for land building processes.	US: Continued institutional recognition. Barrier systems continue building and eroding depending on human disruptions of natural geomorphic processes. LA: Continued disruption of deltaic cycle and longshore transport prevents rebuilding of barrier systems; increased storm frequency resulting in net losses of all Louisiana coastal barrier systems. Average rate of long-term (> 100 years) shoreline change is –19.9 ft/yr (6.1 m/yr). Average short-term rate (< 30 years) of shoreline change is 30.9 ft/yr (9.4 m/yr). Total of about 6,337 acres (2,564 ha) barrier habitat restored with beneficial use of dredged material (746 acres [302 ha]) and CWPPRA restoration projects (5,591 acres [2,262 ha]). SA: Annual average land loss of the Terrebonne Basin Barrier Shoreline is56.9 ft per year.	US: Continued institutional recognition. Barrier systems continue building and eroding depending on human disruptions of natural geomorphic processes. LA: Continued disruption of deltaic cycle and longshore transport prevents rebuilding of barrier shorelines, headlands, and islands; continued increased storm frequency results in significant loss of many barrier islands and shorelines. SA: Continued barrier island habitat loss with 3,227 acres of soil resources from all seven islands predicted to be lost over next 50 years, leaving only 6 acres of intertidal habitat at two islands beyond TY50.	US & LA: Continued institutional recognition. Barrier systems continue building and eroding depending on human disruptions of natural geomorphic processes; continued disruption of deltaic cycle and longshore transport prevents rebuilding of barrier shorelines, headlands, and islands; continued increased storm frequency results in significant loss of many barrier islands and shorelines. Implementing the NER with renourishment would result in a modest increase of soil resources. A5 (NER Plan)*:* restore net total of 2,760 acres of barrier soil resources. A11*:* restore net total of 527 acres barrier soil resources. A2*:* restore net total of 1,311 acres barrier soil resources. A3*:* restore net total of 1,838 acres barrier soil resources. A4: restore net total of 2,119 acres barrier soil resources.
Coastal Processes	US, LA, & SA: Natural coastal and Mississippi River and its tributaries processes of longshore transport, erosion, tides, etc., build and deplete barrier systems. Institutional recognition of importance of resources with creation of Minerals Management Service.	US & LA: Natural coastal and Mississippi River and its tributaries processes of longshore transport, erosion, tides, etc., build and deplete barrier systems. Institutional recognition of importance of resources with creation of Minerals Management Service. SA: As barrier land loss continues, hydrologic connections between the gulf and interior areas increase and exacerbate interior land loss and conversion of habitat types. Continued loss of barrier systems result in reduction and loss of the natural protective storm buffering of these barrier systems	US & LA: Natural coastal and Mississippi River and its tributaries processes of longshore transport, erosion, tides, etc., build and deplete barrier systems. Institutional recognition of importance of resources with creation of Minerals Management Service. SA: similar to existing conditions.	US & LA: Similar to no action alternatives (FWOP) A5 (NER)*:* Restoration of four barrier islands, combined with interior marsh creation and restoration measures, would widen the islands sufficiently to prevent breach formation, thereby reducing formation of additional tidal passes, as well as closing existing breaches and over wash areas. An undetermined reduction in tidal prism would also result. These different restoration measures would act together to retard saltwater intrusion into more northern portions of the Terrebonne Basin. A11: a single island version of A5. A2: a single island version of A5. A3: a two island version of A5. A4: a three island version of A5.

SIGNIFICANT RESOURCE	Past Actions (Historic Conditions)	Present Action (Existing Conditions)	Future Without-Project The No Action Alternative	Cumulative Impacts (Comparison of Future With Proposed Action Impacts for each Restoration Alternative and the NER)
Salinity Regimes	US: Geomorphic and marine processes influence the tidal prism and salinity regimes. LA & SA: Salinity regimes in subprovinces naturally fluctuate in response to deltaic cycle, geomorphic and marine processes, as well as other natural factors influencing the tidal prism.	US: Natural and human disruption of geomorphic and marine processes modify tidal prisms, influence salinity regimes, and facilitates saltwater intrusion into upper estuaries. LA: Human disruption of the deltaic cycle and geomorphic and marine processes, including construction of navigation and oil and gas access channels, modifies tidal prism and resulting in saltwater intrusion and higher salinities within interior portions of estuaries. SA: Continued land loss, increases in the number of in tidal inlets, disruption of the tidal prism, and conversion of barrier habitat and saline marsh habitat to open water alters salinity regimes.	US: Continued natural and human disruption of geomorphic and marine processes modify tidal prisms, influence salinity regimes, and facilitate saltwater intrusion into upper estuaries. LA: Continued human disruption of deltaic cycle and other geomorphic and marine process allow saltwater intrusion into upper estuaries; navigation and oil and gas canals/channels continue to facilitate saltwater intrusion. SA: Continued land loss, increased breaching, and increase in numbers of tidal inlets, disruption of the tidal prism, and conversion to open water alters salinity regimes.	US & LA: Continued natural and human disruption of geomorphic and marine processes modify tidal prisms, influence salinity regimes, and facilitate saltwater intrusion into upper estuaries. Continued human disruption of deltaic cycle and other geomorphic and marine processes that allows saltwater intrusion into upper estuaries; navigation and oil and gas canals/channels continue to facilitate saltwater intrusion. Implementing the NER would result in a comparatively small reduction to the human perturbations and disruption of salinity regimes. A5 (NER): Implementation would result in little, if any impacts on salinity regimes. A11: similar to NER. A2: similar to NER. A3: similar to NER. A4: similar to NER.
Water Quality	US, LA & SA: Degraded waterbodies due to untreated and uncontrolled discharges, especially in urbanized and/or industrialized areas. Enactment of Federal and State legislation (e.g. Clean Water Act) beginning in the 1970s to restore and protect waterbodies, especially with respect to point sources.	US: Continued institutional regulation. Nonpoint sources unregulated. According to the National Water Quality Inventory 2000 Report about 39 percent of streams, 45 percent of lakes, and 51 percent of estuaries assessed were not clean enough to support uses such as fishing and swimming). LA: Hurricane Katrina (2005) causes 10 major oil spills and 35 minor oil spills (total of 7,340,990 gallons) in southeast Louisiana http://www.laseagrant.org/hurricane/oil.htm). SA: 53,000-gallon oil spill from Chevron facility at Port Fourchon (source: http://www.laseagrant.org/hurricane/oil.htm).	US, LA & SA: Continued Present Action. LA & SA: Increasing potential for accidental discharges due to exposed infrastructure because of coastal land loss.	US & LA: Continued Federal and State programs that require and/or encourage protection of waterbodies. A5 (NER): Short term and minor water quality impacts primarily during construction e.g., increased turbidity, decreased DO associated with placement of dredged material. A11: similar to NER. A2: similar to NER. A3: similar to NER. A4: similar to NER.

SIGNIFICANT RESOURCE	Past Actions (Historic Conditions)	Present Action (Existing Conditions)	Future Without-Project The No Action Alternative	Cumulative Impacts (Comparison of Future With Proposed Action Impacts for each Restoration Alternative and the NER)
Vegetation Resources	US, LA & SA: Natural processes form vegetated barrier habitats and coastal wetlands. Institutional recognition of coastal barrier resources and wetlands (e.g., Coastal Barrier Resource Act, Estuary Protection Act, and others). LA: Accelerated deterioration and loss of Louisiana coastal wetlands of over 1.22 million acres (485,830 ha) since the 1930s.	US & LA: Continued institutional recognition. Natural processes such as subsidence, wave erosion, as well as human activities causes deterioration and loss of vegetated barrier and wetland habitat. SA: the individual islands of the Terrebonne Basin Barrier Shoreline are losing vegetated wetlands at varying rates. By target year 50 the islands will have lost all upland area and a total of 1,560 acres of vegetated wetland habitat. The two remaining islands will be represented only by 2 and 4 acres of vegetated wetland.	US: Continued institutional recognition. Continued loss of wetlands and vegetative acreage due to natural processes and human activities. LA: Continued accelerated coast wide loss vegetated barriers systems. Most severe loss in Nation. SA: Land loss rates continue similar to existing conditions.	US: Continued institutional recognition. Continued loss of vegetative acreage due to natural processes and development. Implementing first component of construction would result in a comparatively small reduction to the rate of loss of vegetation habitat. LA: Continued accelerated coast wide loss of vegetated barriers systems; most severe loss in Nation. Implementing the NER would result in a significant increase in the area of vegetated habitat. A5 (NER): Net total of 1459 acres of vegetated barrier habitats restored. Plantings of native species increase important and critical vegetated habitats used by fish and wildlife. A11: similar to NER except a net total of 311 acres. A2: similar to NER except a net total of 706 acres. A3: similar to NER except a net total of 1,117 acres. A4: similar to NER except a net total of 1,120 acres.
Wildlife Resources	US, LA & SA: Vast expanses of coastal wetlands and barrier systems provide diversity of habitats that enable wildlife populations to respond to natural population-regulating mechanisms. Institutional recognition of importance of resource with creation of U.S. Fish and Wildlife Service. Coastal land loss of over 1,900 square miles (492,097 ha) since the 1930s, most of which were suitable wildlife habitats.	US, LA & SA: Continued land loss results in decline and loss of suitable wildlife habitats; increased interspecific and intraspecific competition for decreasing habitats. LA: About 6,337 acres (2,564 ha) of barrier habitat restored with beneficial use of dredged material (746 acres [302 ha]) and CWPPRA restoration projects (5,591 acres [2,262 ha]) most of which were suitable wildlife habitats. SA: Terrebonne Basin Barrier Shoreline is currently losing wildlife habitat at a mean rate of 57 ft/yr.	US, LA, & SA: Continued land loss results in decline of suitable habitats and increased interspecific and intraspecific competition for decreasing habitats. SA: By TY50, the LCA TBBSR Study could lose 3,221 acres of wildlife habitats from all but two of the islands, which would retain 6 acres of intertidal wetland.	US & LA: Continued land loss results in decline of suitable wildlife habitats and increased interspecific and intraspecific competition for decreasing habitats. Implementing the NER would result in an increase in suitable wildlife habitats, which should be a positive impact to wildlife populations. A5 (NER): Restore a total of 2738.6 AAHUs for a net total of 2760 acres of important and essential vegetated habitats used by wildlife for shelter, nesting, feeding, roosting, cover, migratory neotropical bird stopover habitat, nursery, and other life requirements. A11: similar to NER except restore a total of 557.9 AAHUs and a net total of 527 acres A2: similar to NER except a total of 1,206.6 AAHUs and a net total of 1,311 acres A3: similar to NER except a total of 1,764.5 AAHUs and a net total of 1,800 acres A4: similar to NER except a total of 2,268.3 AAHUs and a net total of 2382 acres.

SIGNIFICANT RESOURCE	Past Actions (Historic Conditions)	Present Action (Existing Conditions)	Future Without-Project The No Action Alternative	Cumulative Impacts (Comparison of Future With Proposed Action Impacts for each Restoration Alternative and the NER)
Fisheries Resources	US: Fisheries habitats generally reduced, while catch increased. Institutional recognition with creation of National Marine Fisheries Service. LA & SA: Disruption of deltaic cycle; reduction in sustainability of fisheries habitat, while access (marsh edge) increased; increased productivity and catch.	US: Regulated catch; habitat loss decreased by coastal restoration efforts, continued net habitat loss. Institutional recognition of essential fish habitat. LA: Total of about 6,337 acres barrier habitat restored with beneficial use of dredged material (746 acres) and CWPPRA restoration projects (5,591 acres) restores various fishery habitats (e.g., nursery habitat, and other). LA & SA: Sustained to increasing populations of fish resources. However, now experiencing loss of essential fish habitat, especially barrier habitats and coastal wetlands that function as nursery.	US, LA & SA: Continued loss and degradation of essential fish habitat; net loss in fisheries population size and diversity.	US & LA: Continued loss of essential fish habitat; net loss in fisheries population size and diversity. Implementing the NER would result in a comparatively small improvement, nationwide, in fisheries populations and diversity. A5 (NER): Net total of 2,097 acres of intertidal estuarine habitats used for spawning, nursery, nesting, and foraging by commercially and recreationally important species of finfish and shellfish, as well as other aquatic organisms. A11: similar to NER except a net total of 363 acres. A2: similar to NER except a net total of 1,075 acres. A3: similar to NER except a net total of 1,438 acres. A4: similar to NER except a net total of 1,629 acres.
Essential Fish Habitat (EFH)	US, LA & SA: Institutional recognition of the decline in essential fish habitat (Magnuson-Stevens Fishery Conservation and Management Act). General decrease in quality and quantity of essential fish habitat.	US: Continued institutional recognition. Continued degradation and loss of essential fish habitat. LA: Total of about 6,337 acres barrier habitat restored, or authorized for restoration with beneficial use of dredged material (746 acres) and CWPPRA restoration projects (5,591 acres) restores essential fish habitats. SA: Barrier habitat and coastal wetland losses leads to loss and degradation of essential fish habitat.	US, LA & SA: Continued institutional recognition. Continued degradation and loss of essential fish habitat.	US & LA: Continued degradation and loss of essential fish habitat. Implementing the NER would result in a comparatively small improvement, nationwide, in essential fish habitat. A5 (NER): Net total of 2,097 acres of intertidal estuarine habitats used for spawning, nursery, nesting, and foraging by commercially and recreationally important species of finfish and shellfish, as well as other aquatic organisms. A11: similar to NER except a net total of 363 acres. A2: similar to NER except a net total of 1,075 acres. A3: similar to NER except a net total of 1,438 acres. A4: similar to NER except a net total of 1,629 acres.

SIGNIFICANT RESOURCE	Past Actions (Historic Conditions)	Present Action (Existing Conditions)	Future Without-Project The No Action Alternative	Cumulative Impacts (Comparison of Future With Proposed Action Impacts for each Restoration Alternative and the NER)
Water Bottoms and Benthic Resources	US, LA & SA: The benthic community is a storehouse of organic matter and inorganic nutrients, as well as a site for many vital chemical exchanges and physical interactions. Benthic populations respond to natural population-regulating conditions such as predation, sediment characteristics, salinity regimes, position in the intertidal zone, and oxygen levels.	US: The benthic community is a storehouse of organic matter and inorganic nutrients, as well as a site for many vital chemical exchanges and physical interactions. Benthic populations respond to natural and human-induced perturbations to aquatic habitats. LA & SA: Benthic populations of saline-tolerant species become more prevalent in interior and upper portions of subprovinces as land loss and saltwater intrusion continues.	US: The benthic community is a storehouse of organic matter and inorganic nutrients, as well as a site for many vital chemical exchanges and physical interactions. Benthic populations continue to respond to natural and human-induced perturbations to barrier systems. LA & SA: Benthic populations of saline-tolerant species continue to become more prevalent in interior and upper portions of subprovinces as land loss and saltwater intrusion continues.	US & LA: The benthic community is a storehouse of organic matter and inorganic nutrients, as well as a site for many vital chemical exchanges and physical interactions. Benthic populations continue to respond to natural and human-induced perturbations. Implementing the NER would result in a comparatively small reduction, nationwide, to the predominance of saline-tolerant populations. A5(NER): 79,427,267 cy borrow material required that directly impacts a total of 4,086 acres of water bottoms A11: 26,940,249 cy borrow material required that directly impacts a total of 1,394 acres of water bottoms A2: 24,027,311 cy borrow material required that directly impacts a total of 1,260 acres of water bottoms A3: 50,967,560 cy of borrow required that directly impacts a total of 2,654 acres of water bottoms A4: 65,623,620 cy of borrow required that directly impacts a total of 3,412 acres of water bottoms.
Plankton Resources	US, LA & SA: Plankton populations respond to natural population-regulating conditions (biological factors, tidal flushing, inflow of freshwater carrying organic detritus and dissolved organic compounds, river discharge, water depth, tidal changes, turbidity, and dissolved oxygen).	US: Plankton populations respond to natural and human-induced perturbations to aquatic habitats. LA: Plankton populations in interior and upper portions of subprovinces are becoming more saline-dominant species as land loss and saltwater intrusion into these interior regions continues. SA: Species switching from fresh to saline-tolerant plankton populations that predominate much of the area.	US: Plankton populations continue to respond to natural and human-induced perturbations to aquatic habitats. LA & SA: Continued land loss throughout coastal Louisiana and the Study Area contributes to saltwater intrusion thereby favoring saline-tolerant plankton populations.	US: Plankton populations continue to respond to natural and human-induced perturbations to aquatic habitats. Implementing the NER would result in a comparatively small reduction to the predominance of saline-tolerant populations. LA: Continued land loss throughout coastal Louisiana and the Study Area contributes to saltwater intrusion, thereby favoring saline-tolerant plankton populations. Implementing the NER would result in a comparatively small reduction to the predominance of saline-tolerant populations. A5 (NER): Restoration of 2,097 net acres would increase the amount of dissolved organic compounds and detritus exported from the created and nourished barrier habitats thereby benefiting local plankton populations by increasing the planktonic food supply. A11: Impacts similar to NER except 363 net acres would create greater benefits to plankton resources. A2: Impacts similar to alternative NER except 1,075 net acres would create greater benefits to plankton resources. A3: Impacts similar to NER except 1,438 net acres would create greater benefits to plankton resources. A4: Impacts similar to NER except 1,629 net acres would create greater benefits to plankton resources.

SIGNIFICANT RESOURCE	Past Actions (Historic Conditions)	Present Action (Existing Conditions)	Future Without-Project The No Action Alternative	Cumulative Impacts (Comparison of Future With Proposed Action Impacts for each Restoration Alternative and the NER)
Threatened & Endangered Species	US, LA & SA: General decrease in populations and their critical habitats. Institutional recognition of decline in threatened and endangered species (Endangered Species Act) and their critical habitat.	US & LA: Continued institutional recognition of decline in threatened and endangered species and their critical habitat as National and State loss of species and their critical habitat continue. Total of about 6,337 acres barrier habitat restored with beneficial use of dredged material (746 acres) and CWPPRA restoration projects (5,591 acres) contribute to various habitats for threatened and endangered species. SA: Continued loss of barrier habitat and coastal wetlands resulting in loss of critical habitat (such as the gulf shoreline) for piping plover and other threatened or endangered species.	US: Continued institutional recognition of decline in threatened and endangered species and their critical habitat as National and State loss of species and their critical habitat continue. Potential weakening of Endangered Species Act especially with regard to critical habitat. LA: Continued loss of barrier habitat and coastal wetlands resulting in loss of critical habitat (such as the gulf shoreline) for piping plover. SA: Continued loss of barrier habitat and coastal wetlands resulting in loss of critical habitat (such as the gulf shoreline) for piping plover and other threatened or endangered species.	US & LA: Likely continue to institute individual species recovery plans to maintain or increase populations and their critical habitat. However, this would occur within a framework of continued loss of critical habitat. Potential weakening of Endangered Species Act especially with regard to critical habitat. Implementing the NER would result in a comparatively small reduction, nationwide, to the loss critical habitat and threatened and endangered species. A5 (NER): would not be likely to adversely impact brown pelican or piping plover or piping plover critical habitat; and would not adversely impact any other threatened or endangered species or their critical habitat. NER would restore 2,760 net acres of barrier habitats, including critical habitat for piping plover. A11: similar to NER except a net total of 527 acres A2: similar to NER except a net total of 1,311 acres A3: similar to NER except a net total of 1,838 acres A4: similar to NER except a net total of 2,119 acres.
Historic & Cultural Resources	US, LA & SA: Historic & cultural resources subjected to natural processes and man made actions. Institutional recognition via National Historic Preservation Act (and others).	US, LA & SA: Human activities as well as natural processes can potentially degrade and/or destroy historic and cultural resources	US, LA & SA: Human activities as well as natural processes can potentially degrade and/or destroy historic and cultural resources	US & LA: Human activities as well as natural processes can potentially degrade and/or destroy historic and cultural resources. A5 (NER): would work synergistically with other restoration projects to provide critical and essential barrier islands, which, in turn, would provide some protection to cultural resources that may otherwise be damaged or lost due to coastal land loss. A11: similar to NER. A2: similar to NER. A3: similar to NER. A4: similar to NER.
Population	US, LA & SA: Increasing populations in coastal areas.	US & LA: Large population centers and employment and tourist activities. SA: Study area is remote, uninhabited, and inaccessible except by boat or aircraft.	US & LA: Increasing population in urban and suburban areas, retreating population in rural coastal areas as land loss continues. SA: Study area is remote and uninhabited.	US & LA: Increasing populations in urban and suburban areas, retreating population in rural coastal areas as land loss continues. A5(NER): Study area is remote and uninhabited. A11: Study area is remote and uninhabited. A2: Study area is remote and uninhabited. A3: Study area is remote and uninhabited. A4: Study area is remote and uninhabited.

SIGNIFICANT RESOURCE	Past Actions (Historic Conditions)	Present Action (Existing Conditions)	Future Without-Project The No Action Alternative	Cumulative Impacts (Comparison of Future With Proposed Action Impacts for each Restoration Alternative and the NER)
Infrastructure	US, LA & SA: Increasing infrastructure in the form of roads, bridges, pipelines, homes, and businesses.	US: Heavy concentration of infrastructure throughout coastal communities nationwide. LA: Heavy concentration of infrastructure in several parts of the State. SA: There is no public infrastructure on the barrier islands. Private infrastructure consists of oil and natural gas wells, transmission lines, and petroleum distribution, storage, and processing facilities. All are at risk of damage and/or loss due to barrier island land loss storm impacts.	US: Heavy concentrations of infrastructure along coastal areas nationwide. LA: Increasing damage to coastal infrastructure, reduced development of infrastructure in areas nearest to coast; relocation of some existing infrastructure assets. SA: The effects of continued land loss and degradation would lead to increased costs for maintaining, protecting, and repairing existing infrastructure.	US & LA: Heavy concentration of infrastructure along coastal areas nationwide. Increasing damage to coastal infrastructure, reduced development of infrastructure in areas nearest to coast; relocation of some infrastructure assets. A5 (NER): restoration of the islands, in combination with private protection measures, would provide some undetermined level of protection to infrastructure on and adjacent to the islands. A11: similar to NER. A2: similar to NER. A3: similar to NER. A4: similar to NER.
Commercial Fisheries	US, LA & SA: Increases in fisheries industry, due to advancing technologies and increased fishing pressure.	US, LA & SA: Regulation of fishing maintains a billion dollar industry. LA: Total of about 6,337 acres barrier habitat restored with beneficial use of dredged material (746 acres) and CWPPRA restoration projects (5,591 acres) contribute to various fishery habitats.	US: Some decline expected as vulnerability of habitat increases. More regulation would be necessary to maintain a sustainable industry. LA & SA: Severe decline as coastal land loss continues.	US & LA: Decline in commercial fisheries expected as vulnerability of habitat increases. A5(NER): Net total of 2,097 acres of transitional estuarine-marine habitats used for spawning, nursery, nesting, and foraging by commercially and recreationally important species of finfish and shellfish, as well as other aquatic organisms. This would be in addition to restoration of similar habitats by other barrier habitat restoration projects. A11: similar to NER except a net total of 363 acres A2: similar to NER except a net total of 1,075 acres A3: similar to NER except a net total of 1,438 acres A4: similar to NER except a net total of 1,629 acres.
Oyster Leases	US: Only major oyster leasing program is in Louisiana. LA & SA: General increase in acreage leased, production limited by saltwater intrusion in areas with no freshwater introduction.	US: Only major leasing program is in Louisiana. LA: Leveling off of acreage leased, production limited by saltwater intrusion in areas with no freshwater introduction. Production limited in areas by mortality from over freshening by diversions. SA: 182,399 acres of oyster leases throughout Study Area.	US: Only major leasing program is in Louisiana. LA & SA: Gradual loss of production from leases near gulf coast due to increased salinities. Increased production in areas nearer freshwater introductions.	US & LA: Only major leasing program is in Louisiana. A5(NER): synergistic effect of implementing NER with a net total of 2,097 acres of intertidal estuarine habitat and additive combination of impacts and benefits for overall net acres restored by other Federal, State, local and private restoration efforts. A11: similar to NER except a net total of 363 acres. A2: similar to NER except a net total of 1,075 acres. A3: similar to NER except a net total of 1,438 acres. A4: similar to NER except a net total of 1,629 acres.

SIGNIFICANT RESOURCE	Past Actions (Historic Conditions)	Present Action (Existing Conditions)	Future Without-Project The No Action Alternative	Cumulative Impacts (Comparison of Future With Proposed Action Impacts for each Restoration Alternative and the NER)
Oil, Gas, & Mineral	US, LA & SA: Increasing development of refineries, wells, and other oil and gas producing facilities and equipment.	US, LA & SA: Large investment in refineries, wells, and other oil and gas producing facilities and equipment.	US, LA & SA: Increased damages to refineries, wells, and other oil and gas producing facilities and equipment; probable relocations of these assets.	US & LA: Same as FWOP, except implementation of the NER would reduce damages to oil and gas producing facilities and equipment; and reduced relocations of these assets (as compared to the without-project condition). A5 (NER): implementation provides the cumulative impact of protecting oil and natural gas wells, transmission lines, pumping, storage, and processing facilities located both on and behind the barrier islands by providing restored, revegetated, and breach resistant uplands, thereby increasing protection from future storm surges. A11: similar to NER. A2: similar to NER. A3: similar to NER. A4: similar to NER.
Navigation	US, LA & SA: Increasing port facilities and inland waterways and traffic.	US, LA & SA: Large investment in port facilities and inland waterways and traffic.	US & LA: Probable damages to and relocation of port facilities and inland waterways and traffic. SA: potential for increased frequency and cost for maintenance of the Houma Navigation Canal (a Federal channel) and numerous privately-maintained channels.	US & LA: Greater investment in port facilities and inland waterways (as compared to the without-project condition). Implementing the NER would have an undetermined, but positive effect on navigation channels in the Terrebonne Basin by reducing the impact of storms and storm surges on the sediment that causes shoaling. A5 (NER): cumulative, but undetermined positive impact on Houma Navigation Canal and other private channel maintenance costs and frequency. A11: similar to NER. A2: similar to NER. A3: similar to NER. A4: similar to NER.
Flood Control	US, LA & SA: Construction of flood control levees, pumping stations, and control structures.	US, LA: Large investment in flood control levees, pumping stations, and control structures. SA: There are no flood control structures or systems in the SA.	US, LA: Increased investment in flood control levees, pump stations, and other flood control facilities to prevent damage due to land loss. SA: There are no flood control structures or systems in the SA.	US & LA: Reduced investment in flood control facilities (as compared to without-project conditions). A5 (NER): While increasing the island acreage would not reduce storm surge or wave heights in the area, it would have the effect of lowering storm surge impacts on existing wetlands and land links in the Terrebonne Basin. A11: similar to NER. A2: similar to NER. A3: similar to NER. A4: similar to NER.

SIGNIFICANT RESOURCE	Past Actions (Historic Conditions)	Present Action (Existing Conditions)	Future Without-Project The No Action Alternative	Cumulative Impacts (Comparison of Future With Proposed Action Impacts for each Restoration Alternative and the NER)
Pipelines	US, LA & SA: Development of extensive network of oil and gas pipelines.	US, LA & SA: Large investment in extensive network of oil and gas pipelines; increasing damages to and some relocation of these assets.	US, LA & SA: Increased damages and probable relocations of pipeline assets due to continued coastal land loss.	US & LA: Increased damages and probable relocations of pipeline assets due to continued coastal land loss. A5 (NER): the cumulative impact of protecting both buried and exposed pipelines by providing an additional layer of soil protection, thereby increasing protection against ongoing erosion and future storm surges. A11: similar to NER. A2: similar to NER. A3: similar to NER. A4: similar to NER.
Hurricane Risk Reduction Levees	US and LA: Construction of hurricane risk reduction levees and pumping capacity. SA: No hurricane risk reduction levees within or nearby the Study Area.	US, LA: Large investment in hurricane risk reduction levees and pumping capacity. SA: No hurricane risk reduction levees within or nearby the Study Area.	US, LA: Increasing investment in hurricane risk reduction facilities to prevent damage due to land loss. SA: No hurricane risk reduction levees within or nearby the Study Area.	US & LA: Increasing investment in hurricane risk reduction facilities to prevent damage due to land loss. Implementing the NER would have no effect on hurricane risk reduction levees. A5 (NER): No hurricane risk reduction levees within or nearby Study Area. A11: same as NER. A2: same as NER. A3: same as NER. A4: same as NER.
Agriculture	US, LA & SA: Not an issue.	US, LA & SA: Institutional recognition. LA: Saltwater intrusion, especially in Chenier Plain problem for rice farmers. SA: There are no agriculture activities in Study Area.	US: Continued institutional recognition. LA: Continued coastal land loss and saltwater intrusion reduces opportunities for agriculture. SA: No agriculture activities in Study Area.	US: Continued institutional recognition. Implementing the NER would not impact agriculture endeavors. LA: Continued coastal land loss and saltwater intrusion reduces opportunities for agriculture. Implementing the NER would not impact agriculture endeavors. All Alternatives: No agriculture activities in Study Area.
Forestry	US, LA & SA: Not an issue.	US: Institutional regulation of forest harvest practices. LA: Institutional regulation of forest harvest practices. Continued coast wide forest deterioration, especially swamp and fresh wetland forests. SA: There are no forestry or silviculture activities in Study Area.	US: Continued institutional recognition; however, increasing human populations result in continued loss of forested areas and reduces forestry opportunities. LA: Continued land loss and saltwater intrusion reduces forestry opportunities. SA: No forestry or silviculture activities in Study Area.	US & LA: Continued institutional recognition; increasing human population growth and continued demand for diminishing forestry resources and reduced forestry opportunities. Implementing the NER would have no impacts on forestry. All Alternatives: No forestry activities in Study Area.

SIGNIFICANT RESOURCE	Past Actions (Historic Conditions)	Present Action (Existing Conditions)	Future Without-Project The No Action Alternative	Cumulative Impacts (Comparison of Future With Proposed Action Impacts for each Restoration Alternative and the NER)
Water Supply	US, LA & SA: Not an issue.	US & LA: Significant investment in water supply facilities (treatment plants, pipelines, etc.). SA: There are no water supply facilities within the Study Area.	US & LA: Significant investment in water supply facilities (treatment plants, pipelines, etc.). SA: There are no water supply facilities within the Study Area	US & LA: Continued institutional recognition; continued saltwater intrusion; continued industrial pollution; continued changes to hydrology that affect water supply to wetlands. All Alternatives: No water supply facilities in Study Area.
Aesthetics	US, LA & SA: Generally not an issue until recent times. Institutional recognition via Wild and Scenic Rivers Act, Scenic Byways, and others. Technical recognition via 1988 USACE Visual Resources Assessment Procedure.	US & LA: Human population growth, development, and other human activities have the potential to destroy, enhance, or preserve visual resources. SA: The islands provide aesthetically pleasing views of beach, dune, and marsh habitats.	US, LA: Continued human population growth and development and other human activities have the potential to destroy, enhance, or preserve visual resources. SA: As the islands continue to erode and migrate north they will eventually disappear (by TY50), thus the view will convert to one of open water and scattered petroleum-related structures.	US & LA: Continued human population growth and development and other human activities have the potential to destroy, enhance, or preserve the quality of scenic byways and other undetermined visual resources. A5(NER): The increase in beach, dune, and marsh environments would increase visual quality, increase the potential for long term storm protection to coastal Louisiana, provide some habitat restoration for wildlife and fisheries resources that also play a vital role in the “living landscape,” and provide scale to critical view sheds. A11: similar to NER. A2: similar to NER. A3: similar to NER. A4: similar to NER.
Recreation Resources	US, LA & SA: Generally not an issue until recent times.	US: Nation-wide recreation resources are provided primarily by the U.S. Departments of the Interior and Agriculture. LA & SA: Widespread coastal land loss causes dramatic changes in recreation opportunities.	US, LA & SA: Potential loss of recreational resource base due to coastal land loss, including the barrier islands and the interior islands and marshes.	US & LA: Slowing or reversing land loss and coastal erosion may protect recreation resources. Implementing the NER would improve the recreational opportunities provided by the islands by increasing their habitat areas and protecting them into the future. A5 (NER): the effects of implementing restoration with a net benefit of 2,760 acres of beach, dune, and marsh over 50 years will be felt across the Terrebonne Basin, particularly in the communities that support the recreational fishing, hunting, and ecotourism industries. The Terrebonne Basin is a world-renowned destination for recreational anglers. A11: similar to NER except a net total of 527 acres. A2: similar to NER except a net total of 1,311 acres. A3: similar to NER except a net total of 1,838 acres. A4: similar to NER except a net total of 2,119 acres.

SIGNIFICANT RESOURCE	Past Actions (Historic Conditions)	Present Action (Existing Conditions)	Future Without-Project The No Action Alternative	Cumulative Impacts (Comparison of Future With Proposed Action Impacts for each Restoration Alternative and the NER)
Noise	US, LA & SA: Generally not an issue until recent times. Institutional recognition - Noise Control Act of 1972.	US, LA & SA: Nuisance noise generally associated with areas of human development and activities e.g., boats, airboats, and other human activities may cause disturbances to fish and wildlife in remote regions of the Study Area.	US, LA & SA: Continued human population growth & development, recreation activities, industry, and other human activities typically have some associated noise pollution. Further institutional recognition likely to be enacted.	US & LA: Continued human population growth & development, recreation activities, industry, and other human activities typically have some associated noise pollution. Further institutional recognition likely to be enacted. SA: Raccoon, Whiskey, and Wine Islands are State-managed wildlife refuges and public trespass is prohibited. A5 (NER): cumulative impacts are primarily related to potential short-term disruption, during construction activities, of wildlife species, most critically in bird rookeries and shorebird nesting areas. This will be addressed in cooperation with resource management agencies during project planning and implementation. A11: similar to NER. A2: similar to NER. A3: similar to NER. A4: similar to NER.
HTRW	US, LA & SA: Generally not an issue until recent times. Natural sources of HTRW supplanted by human-induced HTRW. Institutional recognition (1976) RCRA, (1980) CERCLA, (1986) SARA, (1992) USACE via ER 1165-2-132 Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance.	US & LA: Continued human population growth and development, industry, and other human activities would typically have some HTRW associated with them. Further institutional recognition would likely be enacted. SA: Phase 1 investigation found no HTRW concerns.	US, LA & SA: Continued human population growth and development, industry, and other human activities would typically have some HTRW associated with them. Further institutional recognition would likely be enacted.	US & LA: Continued human population growth and development, industry, and other human activities typically have some HTRW associated with them. Further institutional recognition likely to be enacted. A5 (NER): Consistent with ER 1165-2-132, an HTRW investigation was conducted for the Study Area. Based upon findings from this investigation, the potential for cumulative impacts to the Study Area from implementation of the NER would be low and would likely continue to be low into the future. A11: similar to NER. A2: similar to NER. A3: similar to NER. A4: similar to NER.
Air Quality	US, LA & SA: Generally not an issue until recent times. Institutional recognition of resource via Clean Air Act. General deterioration of air quality due to increases in human populations and industry.	US, LA & SA: Continued institutional recognition. Continued deterioration of air quality due to increases in human populations, industrial activities, and motorized machinery/equipment/vehicle emissions.	US, LA & SA: Continued deterioration of air quality due to increases in human populations, industrial and motorized machinery/equipment/vehicle emissions.	US & LA: Continued deterioration of air quality due to increases in human populations, industrial activities, and motorized vehicle, equipment, and vessel emissions. A5(NER**): C**umulative impacts would primarily be related to direct air emissions during construction activities and would be reduced to background following construction completion. The background would likely continue to be low into the future. A11: similar to NER. A2: similar to NER. A3: similar to NER. A4: similar to NER.

This environmental analysis evaluates and compares, from a qualitative and quantitative perspective, the No Action Alternative (Future Without Project Conditions) to the four alternatives carried over for detailed analysis. Impact analysis described in this chapter is based on a combination of scientific and engineering analyses, professional judgment, and previously compiled information.

5.1 SOILS AND WATER BOTTOMS

5.1.1 Soils

5.1.1.1 No Action Alternative (Future without Project Conditions)

5.1.1.1.1 Direct

The No Action Alternative, not implementing the Terrebonne Basin Barrier Shoreline Restoration project, would have no direct impacts on soil resources within the seven island barrier system. Existing conditions, including continued barrier island deterioration, fragmentation, degradation and the eventual loss of the barrier islands and their associated environmental values and functions would persist..

5.1.1.1.2 Indirect

Without any action, approximately 3,220 acres of existing barrier soil resources from the seven island Terrebonne Basin barrier system (East Timbalier, Timbalier, Trinity, East Island, Wine, Whiskey and Raccoon Island) would likely continue to deteriorate, degrade, fragment and eventually convert into shallow open water bottoms. The Terrebonne Basin barrier island system would continue to experience higher wave energy levels and associated shoreline erosion in the adjacent bays (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005). If the Terrebonne Basin barrier island system is not restored, the adjacent estuarine bay systems, along with their soil resources, will continue to be transformed into marine open water habitat. The loss of soil resources would adversely impact important transitional habitat between estuarine and marine environments; essential fish habitat (EFH); unique wildlife habitat (e.g., nursery, nesting, feeding, and roosting habitats); and critical wintering habitat for the threatened piping plover. The continued degradation and eventual loss of soil resources would result in the loss of fish and wildlife habitat which would likely increase competition between and within various fish and wildlife species for diminishing habitat resources. The loss of vegetated wetlands would also result in a loss in primary productivity and eventually result in conversion of the existing back bay estuarine system into more marine open water system.

5.1.1.1.3 Cumulative

Louisiana has lost approximately 1,900 square miles of coastal wetland soil resources since the 1930's (Dunbar et al. 1992; Barras et al. 1994; Barras et al. 2003). Approximately 10 percent of Louisiana's remaining coastal wetlands would be lost at a rate of approximately 6,600 acres per year (over the next 50 years, resulting in an additional net loss of 328,000 acres by 2050 (Barras et al. 2003). Land loss in the Study Area would likely continue at rates similar to present resulting in the projected loss over all seven of the Terrebonne barrier islands of about 3,220 acres of barrier island soils, primarily Clovelly muck, Scatlake muck, Scatlake-Felicity complex soils, by 2062. This projected loss of barrier island soil resources would be in addition to the projected loss of soil resources throughout coastal Louisiana. The LCA Study (USACE, 2004) estimated coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year over the next 50 years.

However, these soil losses would be offset to some extent by other Federal, State, local, and private restoration efforts across coastal Louisiana (Table 5-2). In addition, more recent restoration efforts would also cumulatively interact to help offset losses of soil resources in the Study Area, including the following:

Table 5-2. Net Acres Created, Restored, and/or Protected by Other Federal, State, Local, and Private Restoration Efforts (USACE, 2004)

	Subprovince 1 (acres)	Subprovince 2 (acres)	Subprovince 3 (acres)	Subprovince 4 (acres)	Totals (acres)
Breaux Act CWPPRA	33,690	44,913	25,057	30,486	134,146
State	2,543	9,043	5,200	1,972	18,758
PCWRP	14	41	371	31	457
Mitigation Civil Works Projects	4,990	0	5,000	0	9,990
Mitigation Regulatory Permits1	6,411	3,199	2,635	2,983	15,228
Vegetation	535	878	1,785	1,931	5,129
Section 204/1135, Beneficial Use	226	414	1,293	3,525	5,458
WRDA	16,000	33,000	0	0	49,000
Other	0	2,000	50,000	3,226	426,132
TOTALS	64,410	93,490	91,344	44,158	664,298

5.1.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.1.1.2.1 Direct

Compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would initially restore a total of 5,840 acres of barrier soil resources including the creation of 3,283 acres in addition to restoration of 2,557 acres of existing barrier soil resources. This alternative would restore Raccoon, Timbalier, Trinity, and Whiskey Islands to their minimal geormorphological form along with 5-years of advanced fill for Trinity and Whiskey Islands and 25-years advanced fill for Raccoon and Timbalier Islands. Following is an island-by-island breakdown of the acres of soil resources created for each of the island components of the NER Plan including the renourishment events.

Alternative 5 (NER Plan) would initially restore a total of 789 acres of barrier soil resources on Raccoon Island, including restoration of 235 acres of existing degrading barrier soil resources and creation of an additional 554 acres of barrier soil resources. Additional direct impacts would include renourishment at target year 30 (TY30) of 658 acres of beach and dune soil resources along Raccoon Island.

Alternative 5 (NER Plan) would initially restore a total of 1,272 acres of barrier soil resources on Whiskey Island including restoration of 820 acres of existing degrading barrier soil resources and creation of an additional 469 acres of barrier soil resources. Additional direct impacts would include renourishment of 929 acres and 905 acres of beach and dune soil resources at TY20 and TY 40, respectively.

Alternative 5 (NER Plan) would initially restore a total of 1,149 acres of barrier soil resources on Trinity Island including restoration of 582 acres of existing degrading barrier soil resources and creation of an additional 585 acres of barrier soil resources. Additional direct impacts would include renourishment of 1,151 acres of beach and dune soil resources at TY25.

Alternative 5 (NER Plan) would initially restore a total of 2,630 acres of barrier soil resources on Timbalier Island including restoration of 979 acres of existing degrading barrier soil resources and creation of an additional 1,675 acres of soil resources. Additional direct impacts would include renourishment of 1,786 acres of beach and dune soil resources at TY 30.

Placement of borrow material would unavoidably bury existing barrier shoreline, dune, marsh, and shallow water bottom soil resources. Following placement, consolidation of borrow material would take about one year. Adverse direct impacts of placing a total of 20,246,338 cy of borrow material into the dynamic high energy Terrebonne Basin barrier system would generally be minimized by placement of like-on-like sediments in this sediment-starved barrier system.

5.1.1.2.2 Indirect

Compared to the No-Action Alternative, indirect impacts of implementing Alternative 5 (NER Plan) would be restoration of a net total of 2,781 acres of barrier island soil resources including 641 net acres on Raccoon, 527 net acres on Whiskey, 289 net acres on Trinity, and 1,324 net acres on Timbalier Islands. Borrow sediments used for barrier restoration would be subjected to biogeochemical processes that would, over time, begin to more closely resemble the Scatlake and Felicity soils that they would be covering. Hence, additional indirect impacts would include the ecological and geomorphologic benefits associated with the deposition and natural redistribution of a total of 67,184,714 cy, including 46,264,549 cy of initial fill and 20,920,165 cy of renourishment of sand and marsh-compatible soils throughout the Terrebonne Basin barrier island system over the 50-year period of analysis.

Restoration of barrier shoreline, dune, back-barrier marsh, and shallow open water soil resources would also indirectly affect plant and animal establishment and growth, invertebrate colonization, and other factors (Callaway 2001). Although there would be some short-term adverse impacts associated with placement of borrow material (e.g., compaction of existing soil horizons) the long-term impacts would generally be positive by providing soil resources suitable for recolonization by plants and animals. Restoration of beach, dune and back barrier marsh soil resources would provide suitable substrate for establishing barrier vegetation resources, which, would increase important transitional fish and wildlife habitat between marine and estuarine environments, provide important barrier shoreline haul-out habitat for threatened and endangered sea turtle, and increase critical wintering habitat for the threatened piping plover thereby facilitating the nation-wide recovery of this threatened species.

5.1.1.2.3 Cumulative

Cumulative impacts would be the incremental impact from implementing Alternative 5 (NER Plan) when added to all past, present and reasonably foreseeable similar barrier restoration efforts. Alternative 5 (NER Plan) would restore a net total of 2,781 acres of barrier soil resources on Raccoon (net total 641 acres), Whiskey (net total 527 acres), Trinity (net total 289 acres), and Timbalier Islands (net total 1,324 acres) which would be in addition to impacts and benefits for overall net acres of barrier soil resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts. Coastal barrier land loss in Louisiana has been addressed, to some degree, by efforts under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 *et. seq*.

5.1.1.3 Alternative 11: Whiskey (Plan C with renourishment)

5.1.1.3.1 Direct

Compared to the No Action Alternative, implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including initial restoration of a total 1,272 acres of barrier soil resources on

Whiskey Island, restoration of 820 acres of existing degrading barrier soil resources and creation of an additional 469 acres of barrier soil resources. Additional direct impacts would include renourishment of 929 acres and 905 acres of beach and dune soil resources at TY20 and TY 40, respectively.

5.1.1.3.2 Indirect

Compared to the No-Action Alternative, indirect impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including restoration of a net total 527 acres over the 50-year period of analysis. Borrow sediments used for restoration of Whiskey Island would be subjected to biogeochemical processes that would, over time, begin to more closely resemble the Scatlake and Felicity soils that they would be covering. Hence, additional indirect impacts would include the ecological and geomorphologic benefits associated with the deposition and natural redistribution of a total of 16,660,430 cy, including 8,909,939 cy of initial fill and 8,330,215 cy of renourishment of sand and marsh-compatible soils throughout the Terrebonne Basin barrier island system over the 50-year period of analysis.

5.1.1.3.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 11 restoring a net total of 527 acres of barrier soil resources on Whiskey Island with the additive combination of impacts and benefits for overall net acres of barrier soil resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts. Coastal barrier land loss in Louisiana has been addressed, to some degree, by efforts under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq.

5.1.1.4 Alternative 2: Timbalier (Plan E)

5.1.1.4.1 Direct

Compared to the No Action Alternative, implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan), including initial restoration of a total 2,630 acres of barrier soil resources on Timbablier Island, restoration of 979 acres of existing degrading barrier soil resources and creation of an additional 1,675 acres of barrier soil resources. Additional direct impacts would include renourishment of 1,151 acres of beach and dune soil resources at TY25.

5.1.1.4.2 Indirect

Compared to the No-Action Alternative, indirect impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) including restoration of a net total 1,324 acres over the 50-year period of analysis. Borrow sediments used for restoration of Whiskey Island would be subjected to biogeochemical processes that would, over time, begin to more closely resemble the Scatlake and Felicity soils that they would be covering. Hence, additional indirect impacts would include the ecological and geomorphologic benefits associated with the deposition and natural redistribution of a total of 20,246,338 cy, including 19,776,135 cy of initial fill and 470,203 cy of renourishment of sand and marsh-compatible soils throughout the Terrebonne Basin barrier island system over the 50-year period of analysis.

5.1.1.4.3 Cumulative

Cumulative impacts would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) including restoring a net total of 1,324 acres of barrier soil resources on Timbalier Island with the additive combination of impacts and benefits for overall net acres of barrier soil resources created, nourished, restored, and/or protected by other Federal, State, local, and private barrier island restoration efforts. Coastal barrier land loss in Louisiana has been addressed, to some degree, by efforts under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 *et. seq.*

5.1.1.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.1.1.5.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 3 would be similar to the direct impacts described above for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan).

The Whiskey Island restoration component of Alternative 3 would initially restore a total 1,272 acres of barrier soil resources, including restoration of 820 acres of existing degrading barrier soil resources and creation of an additional 469 acres of barrier soil resources. Additional direct impacts of the Whiskey Island component of Alternative 3 would include renourishment of 929 acres and 905 acres of beach and dune soil resources at TY20 and TY 40, respectively.

The Timbalier Island component of Alternative 3 would initially restore a total 2,630 acres of barrier soil resources, including restoration of 979 acres of existing degrading barrier soil resources and creation of an additional 1,675 acres of barrier soil resources. Additional direct impacts of the Timbalier Island component of Alternative 3 would include renourishment of 1,151 acres of beach and dune soil resources at TY25.

5.1.1.5.2 Indirect

Compared to the No-Action Alternative, indirect impacts of implementing Alternative 3 would be similar to those described above for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan).

Indirect impacts would include restoration of a net total 1,851 acres (527 net acres on Whiskey Island and 1,324 net acres on Timbalier Island) over the 50-year period of analysis. Borrow sediments used for restoration of Whiskey and Timbalier Islands would be subjected to biogeochemical processes that would, over time, begin to more closely resemble the Scatlake and Felicity soils that they would be covering. Hence, additional indirect impacts would include the ecological and geomorphologic benefits associated with the deposition and natural redistribution of a total of 43,846,142 cy, including 28,686,074 cy of initial fill and 15,160,068 cy of renourishment of sand and marsh-compatible soils throughout the Terrebonne Basin barrier island system over the 50-year period of analysis.

5.1.1.5.3 Cumulative

Cumulative impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Island components of Alternative 5 (NER Plan). The synergistic interaction of implementing both the Timbalier and Whiskey Island restoration components of Alternative 3 would result in a net total of 1,851 acres (Whiskey Island 527 net acres and Timbalier Island 1,324 acres) restored over the 50 year period of analysis along with the additive combination of impacts and benefits for net acres of barrier islands restored by other Federal, State, local, and private restoration efforts.

5.1.1.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.1.1.6.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Island components of Alternative 5 (NER Plan).

The Whiskey Island component would initially restore a total of 1,272 acres of barrier soil resources including restoration of 820 acres of existing degrading barrier soil resources and creation of an additional 469 acres of barrier soil resources. Additional direct impacts would include renourishment of 929 acres and 905 acres of beach and dune soil resources at TY20 and TY 40, respectively.

The Trinity Island component would initially restore a total of 1,149 acres of barrier soil resources including restoration of 582 acres of existing degrading barrier soil resources and creation of an additional 585 acres of barrier soil resources. Additional direct impacts would include renourishment of 1,151 acres of beach and dune soil resources at TY25.

The Timbalier Island component would initially restore a total of 2,630 acres of barrier soil resources including restoration of 979 acres of existing degrading barrier soil resources and creation of an additional 1,675 acres of soil resources. Additional direct impacts would include renourishment of 1,786 acres of beach and dune soil resources at TY 30.

5.1.1.6.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Island components of Alternative 5 (NER Plan). This would include a net total of 2,140 acres of barrier island soil resources including 527 net acres on Whiskey, 289 net acres on Trinity, and 1,324 net acres on Timbalier Islands. Borrow sediments used for barrier restoration would be subjected to biogeochemical processes that would, over time, begin to more closely resemble the Scatlake and Felicity soils that they would be covering. Hence, additional indirect impacts would include the ecological and geomorphologic benefits associated with the deposition and natural redistribution of a total of 55,246,837 cy (cy), including 36,272,884 cy of initial fill and 18,973,953 cy of renourishment of sand and marsh-compatible soils throughout the Terrebonne Basin barrier island system over the 50-year period of analysis.

5.1.1.6.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey, Trinity, and Timbalier Island components of Alternative 5 (NER Plan). This would include the synergistic interaction of restoring a net total of 2,140 acres of barrier soil resources on Whiskey (net total 527 acres), Trinity (net total 289 acres), and Timbalier Islands (net total 1,324 acres) with the additive combination of impacts and benefits for overall net acres of barrier soil resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts. Coastal barrier land loss in Louisiana has been addressed, to some degree, by efforts under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq.

5.1.2 Water bottoms

5.1.2.1 No Action Alternative (Future without Project Conditions)

5.1.2.1.1 Direct

The No Action Alternative, not implementing the Terrebonne Basin Barrier Shoreline restoration, would have no direct impacts on existing water bottoms.

5.1.2.1.2 Indirect

The No Action Alternative would result in the conversion of approximately 3,220 acres of existing Terrebonne Basin barrier island beach, dune and marsh habitats to water bottoms. Conversion of existing barrier island beach, dune and marsh habitat to water bottom habitat would include degradation and loss of important and essential fish and wildlife habitats used for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements; reduction in productivity; degradation and loss of EFH, especially transitional habitat between estuarine and marine environments; degradation and loss of stopover habitat for migrating neotropic birds; and increased inter- and intra-specific competition between resident and migratory fish and wildlife species for decreasing coastal barrier island resources.

5.1.2.1.3 Cumulative

Cumulative impacts to water bottoms would be the synergistic effect of the No-Action Alternative of converting 3,220 acres of existing Terrebonne Basin barrier island habitats to water bottoms, along with the additive combination of approximately 10% of Louisiana's remaining coastal wetlands being converted to water bottoms at a rate of 6,600 acres per year over the next 50 years, resulting in an additional net loss of 328,000 acres by 2050 (Barras et al. 2003). These impacts would be offset, to some degree, by the additive combination of impacts and benefits for overall acres of water bottoms impacted by other Federal, State, local, and private restoration efforts. Coastal water bottoms in Louisiana have been impacted, to some degree, by efforts under the CWPPRA program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 *et. seq*.

5.1.2.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.1.2.2.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 5 (NER Plan) would include impacts to water bottoms within the offshore borrow areas as well as impacts to water bottoms within the barrier island restoration and creation areas. Initial construction would remove a total of 55,787,481 cy of borrow material from a total of 2498 acres of water bottoms in the offshore borrow areas including 1187 acres at Ship Shoal; 744 acres at the South Pelto; 83 acres at Raccoon Island; 87 acres at New Cut; and 397 acres at Whiskey 3A. Renourishment would remove a total of 23,639,786 cy from a total of 1222 acres of water bottoms in offshore borrow areas including 26 acres at South Pelto and 1196 acres at Ship Shoal.

Initial construction would cover a total of 3,283 acres of water bottoms and existing fragmented barrier habitats. Renourishment would directly cover 71 acres at TY30 on Raccoon Island, 474 acres at TY 20 and 349 acres at TY40 on Whiskey Island; 537 acres on Trinity Island at TY 25; and 202 acres on Timbalier Island at TY30.

A total of 3,283 acres of existing water bottoms would be converted to beach, dune and marsh barrier habitats by placement of a total of 55,787,481 cy of borrow material during initial construction. Dredging and placement of borrow material could destroy any slow-moving or sessile benthic organisms found within the borrow areas and within the barrier island restoration/creation areas.

Construction of the terminal groin on Raccoon Island would directly impact a total of 2 acres of Gulf of Mexico water bottoms.

Nairn et al. (2004) conducted an extensive literature review and developed a monitoring program for MMS to evaluate long-term impacts of sand dredging operations on the outer continental shelf (OCS), including Ship Shoal. Primary impacts of concern include changes to the sea bed resulting in changes to the erosion and sedimentation processes along the shore and changes to the sea bed that would have direct and significant impacts on the biological environment including: removal and alteration of substrate; loss of essential fish habitat (EFH); dredging could remove existing benthic community systems in the areas where sands are removed (previous studies have shown recovery within three years); turbidity plumes associated with dredging would elevate levels of suspended inorganic and organic solids; reduction in elevation of the seabed and exposure of the underlying sediment layer with different characteristics such as grain size, reduced dissolved oxygen levels and compaction (Nairn et al. 2004).

Despite completing a cultural survey of the borrow areas, there remains a potential for cultural or historic relics to be disturbed or lost during dredging operation. Despite extensive surveys of the borrow sites, there remains a potential for disturbing oil and gas infrastructure (pipelines, platforms, and other structures). There would also be a potential for incidental takings of sea turtles during dredging operations, despite all possible precautions being taken (e.g., use of turtle exclusion devices, observers, etc.) to avoid, minimize and reduce any such impacts. Sediment plumes created by dredge operations would be small and temporary; consequently, effects to plankton, fish and marine mammals should be minimal and of short duration (Nairn et al 2004; Hardaway et al 1998; Hammer et al 1993).

5.1.2.2.2 Indirect

Indirect impacts to water bottoms of implementing Alternative 5 (NER Plan) would include the natural redistribution, via natural coastal longshore transport processes, of a portion of the total 67,184,714 cy of borrow sediments throughout the Terrebonne barrier island system over the 50-year period of analysis.

The 1,200-ft long terminal groin at Raccoon Island would intersept the net longshore sediment flux, thereby retaining sediment on the beach up-drift of the groin. The terminal groin would reduce longshore erosion by capturing sediments that would otherwise be lost through offshore transport and deposition. The longshore sediment transport moves material off of Raccoon Island to the west and is lost to the shoals and perhaps buried by the mud stream from the Atchafalaya River.

A total of 67,184,714 cy of sediments would be dredged from borrow site water bottoms for use in barrier island restoration. This action could potentially alter wave dynamics, thereby changing onshore storm-wave impacts, possibly leading to greater shoreline erosion. However, Stone et al. (2004) indicates that removal of Ship Shoal sands for barrier/coastal restoration efforts would not significantly influence wave conditions in the nearshore because the expected increase in wave energy is limited to the leeward flank of the shoal. For near-shore borrow areas, the borrow pit would be designed to minimize the potential to alter wave dynamics (including sufficient distance from the existing shoreline).

Other indirect impacts would include: marine organisms that presently utilize the gulf bottom substrates (especially benthos) would have to adapt to changes in gulf bottom topography; restoration construction activities could cause short-term disruption of commercial and recreational fishing; and alteration of gulf water bottoms may change littoral drift dynamics; creation of depressions, furrows, and pits could impact recolonization by the benthic community (Nairn et al 2004). The primary concern is the potential for ridge and shoal type features to deflate or be smoothed out where borrow deposits are accessed on an ongoing basis. This could lead to large-scale impacts to biological communities (Nairn et al. 2004). However, Stone et al. (2004) indicates that removal of Ship Shoal sands for barrier/coastal restoration efforts would not significantly influence wave conditions in the nearshore because the expected increase in wave energy is limited to the leeward flank of the shoal. In addition, the MMS, International Activities and Marine Minerals Division is charged with management of Federal Outer Continental Shelf (OCS) sand and gravel resources that would be used for beach nourishment to repair storm damage and protect against sea-level rise. To reduce potential environmental damage associated with long-term and large-scale use of these resources, a project was funded by MMS to design a comprehensive physical and biological monitoring program for sand-mining activities.

Implementing Alternative 5 (NER Plan) would restore a portion of the natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur) thereby reducing, to some unknown extent, the annual economic loss to Louisiana and the nation (after Van Heerden and DeRouen 1997). Furthermore, the proposed barrier shoreline restoration would contribute to the “Cajun” culture and its people thereby indirectly impacting the State’s economy and advancing by some unknown extent, the economic development of the State of Louisiana.

5.1.2.2.3 Cumulative

Cumulative impacts to water bottoms would be the synergistic effect of implementing Alternative 5 (NER Plan), with impacts to a total of 7,003 acres of water bottoms, along with the additive combination of impacts and benefits of existing wetlands being converted to water bottoms at a rate of 6,600 acres per year over the next 50 years, resulting in an additional net loss of 328,000 acres by 2050 (Barras et al. 2003). As discussed in Chapter 4, barrier resources are utilized by a broad range of fish, wildlife, benthic and humans, thereby benefiting more than just the State of Louisiana. Implementing Alternative 5 (NER Plan) would restore degrading barrier habitats to higher quality barrier habitats, which would likely result in a net increase in important benthic and other barrier resources. The incremental cumulative impacts of implementing Alternative 5 (NER Plan) would be in synergistic combination to impacts and benefits for overall net acres of barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts. Coastal barrier island conversion to water bottoms in Louisiana has been addressed, to some degree, by efforts under the CWPPRA program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 *et. seq.*

5.1.2.3 Alternative 11: Whiskey (Plan C with renourishment)

5.1.2.3.1 Direct

Compared to the No Action Alternative, direct impacts to water bottoms of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan). Initial construction would remove a total of 10,340,701 cy of sediments from a total of 535 acres of borrow site water bottoms including: 487 acres at Ship Shoal, and 48 acres at Whiskey Area 3a. Renourishment would remove a total of 16,599,548 cy of borrow material from a total of 859 acres at Ship Shoal; with 9,413,143 cy removed from 487 acres at TY20 and 7,186,405 cy from 372 acres at TY40.

Initial construction would cover approximately 469 acres of water bottoms and fragmented barrier habitats. Renourishment with borrow material from Ship Shoal would directly impact a total of 474 acres and 349 acres of water bottoms and fragmented barrier habitats at TY20 and TY40, respectively.

5.1.2.3.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the natural redistribution of a portion of the total 26,940,249 cy of sediments throughout the Terrebonne Basin barrier island system over the 50-year period of analysis. Additional indirect impacts would be the prevention of a net total of 527 acres of barrier habitats converting to water bottoms over the 50-year period of analysis.

5.1.2.3.3 Cumulative

Cumulative impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including dredging a total of 26,940,249 cy of sediments from 1,394 acres of existing borrow site water bottoms. These impacts would be offset, to some extent, by the prevention of a net total of 527 acres of barrier habitats converting to water bottoms over the 50-year period of analysis. In addition, implementing Alternative 11 would restore degrading barrier habitats to higher quality barrier habitats, which would likely result in a net increase in important benthic and other barrier resources. These incremental cumulative impacts of implementing Alternative 11 would be in addition to impacts and benefits for acres of barrier islands created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.1.2.4 Alternative 2: Timbalier (Plan E)

5.1.2.4.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan). Initial construction would remove a total of 25,214,803 cy of sediments from a total of 1,375 acres of borrow site water bottoms including: 613 acres at South Pelto and 396 acres at Whiskey 3a (beach and marsh). Renourshiment at TY30 would remove a total of 531,329 cy of borrow material from, 26 acres at South Pelto borrow site.

Initial construction would cover approximately 1,675 acres of existing water bottoms and fragmented barrier habitats. Renourishment at TY30, with borrow material from South Pelto, would directly impact a total of 202 acres of water bottoms and fragmented barrier habitats.

5.1.2.4.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) including the natural redistribution of a portion of the 20,246,338 cy of sediments throughout the Terrebonne Basin barrier island system over the 50-year period of analysis. Additional indirect impacts would be the prevention of a net total of 1,324 acres of barrier habitats converting to water bottoms over the 50-year period of analysis.

5.1.2.4.3 Cumulative

Cumulative impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) including dredging a total of 25,746,132 cy of sediments from a total of 1,375 acres of borrow site water bottoms. These impacts would be offset, to some extent, by the prevention of a net total of 1,324 acres of barrier habitats converting to water bottoms over the

50-year period of analysis. In addition, implementing Alternative 2 would restore degrading barrier habitats to higher quality barrier habitats, which would likely result in a net increase in important benthic and other barrier resources. These incremental cumulative impacts of implementing Alternative 2 would be in addition to impacts and benefits for acres of barrier islands created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.1.2.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.1.2.5.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan). Initial construction would remove a total of 35,381,587 cy of borrow material from a total of 1,535 acres of water bottoms in the offshore borrow areas including 487 acres at Ship Shoal; 613 acres at the South Pelto; 39 acres at Raccoon Island; and 396 acres at Whiskey Area. Renourishment would remove a total of 17,130,877 cy from a total of 885 acres of water bottoms in offshore borrow areas including 27 acres at South Pelto and 859 acres at Ship Shoal.

Initial construction would cover a total of 2,144 acres of water bottoms and existing fragmented barrier habitats. Renourishment would directly cover 474 acres at TY 20 and 349 acres at TY30 on Whiskey Island and 202 acres on Timbalier Island at TY40.

5.1.2.5.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Island components of Alternative 5 (NER Plan) including the natural redistribution of a portion of the 47,186,587 cy of borrow sediments throughout the Terrebonne Basin barrier island system over the 50-yer period of analysis. Additional indirect impacts would be the prevention of a net total of 1,851 acres of barrier habitats converting to water bottoms over the 50-year period of analysis.

5.1.2.5.3 Cumulative

Cumulative impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) with the following exceptions: the synergistic interaction of the effects of implementing the LCA TBBSR Study would directly impact approximately 1,535 acres in the offshore borrow areas and 4,779 acres of water bottoms in the Study Area. In addition, implementing Alternative 3 would restore degrading barrier habitats to higher quality barrier habitats, which would likely result in a net increase in important benthic and other barrier resources. These incremental impacts of implementing Alternative 3 would be in addition to impacts and benefits for acres of barrier islands created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.1.2.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.1.2.6.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan). Initial construction would remove a total of 44,544,496 cy of borrow material from a total of 1,998 acres of water bottoms in the offshore borrow areas including 803 acres at Ship Shoal; 613 acres at the South Pelto; 39 acres at Raccoon Island; 147 acres at New Cut; and 396 acres at Whiskey Area. Renourishment would remove a total of 21,440,567 cy from a total of 1,108 acres of water bottoms in offshore borrow areas including 26 acres at South Pelto and 1,082 acres at Ship Shoal.

Initial construction would cover a total of 2,729 acres of water bottoms and existing fragmented barrier habitats. Renourishment would directly cover 474 acres at TY 20 and 349 acres at TY40 on Whiskey Island; 537 acres on Trinity Island at TY 25; and 202 acres on Timbalier Island at TY30 Island at TY30

5.1.2.6.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Island components of Alternative 5 (NER Plan) including the natural redistribution of a portion of the 55,246,837 cy of borrow sediments throughout the Terrebonne Basin barrier island system over the 50-year period of analysis. Additional indirect impacts would be the prevention of a net total of 2140 acres of barrier habitats converting to water bottoms over the 50-year period of analysis.

5.1.2.6.3 Cumulative

Cumulative impacts of implementing Alternative 4 would be similar to those described for Alternative 5 (NER Plan) with the following exceptions: the synergistic interaction of the effects of implementing the LCA TBBSR Study would directly impact approximately 3,106 acres in the offshore borrow areas and 153 acres of water bottoms in the Study Area. In addition, implementing Alternative 4 would restore degrading barrier habitats to higher quality barrier habitats, which would likely result in a net increase in important benthic and other barrier resources. These incremental cumulative impacts of implementing Alternative 4 would be in addition to impacts and benefits for acres of barrier islands created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.2 Coastal Processes and Hydrology

5.2.1 Flow and Water Levels

5.2.1.1 No action Alternative (Future without Project Conditions)

5.2.1.1.1 Direct

Not implementing proposed restoration of the Terrebonne Basin barrier shoreline would have no direct impacts on coastal processes, flows or water levels.

5.2.1.1.2 Indirect

The primary indirect impacts of not implementing the proposed Terrebonne Basin barrier shoreline restoration measures would be associated with changes in coastal processes. Both natural and human-induced changes to coastal processes of water flows and levels would continue. The natural and human-induced hydrological modifications to coastal processes that have influenced flows and water levels throughout the Louisiana coastal barrier systems is well documented (USACE, 2004). Natural subsidence, barrier shoreline erosion due to waves and storms, construction of oil and gas exploration canals, construction and maintenance (dredge and fill activities) of navigation channels, as well as mineral extraction would continue to contribute to alteration of the natural coastal processes and flow and water levels within the Terrebonne barrier system. These and other influences have resulted and will continue to result in the Terrebonne barrier islands moving, changing shape and decreasing in size over time (Williams et al. 1992). Construction of navigation channels, as well as natural coalescence of tidal passes, will continue to influence coastal processes and the Terrebonne barrier systems.

The Terrebonne barrier system has been displaced by the coalescence of tidal passes (Gosselink and Sasser, 1995). Three main passes that were present in the Terrebonne barrier system in 1891 had coalesced into Cat Island Pass by 1974, part of which is now occupied by the former locations of Callou and Wine Islands (Suter and Penland 1987). This pass, partly dredged and partly natural, continues to dominate estuarine hydraulics within the barrier system despite the opening of numerous shallow storm channels through the deteriorating islands.

Increased channelization, including construction of navigation and oil and gas exploration canals, especially evident on Timbalier and East Timbalier Islands, have altered water flows and contributed to disruption of the longshore transport as well as changing the barrier island rollback dynamics (Penland and Boyd 1985; Penland et al. 1988). These impacts would continue into the future thereby further contributing to Terrebonne barrier island land loss. The continued loss of the Terrebonne barrier system could indirectly impact the adjacent Terrebonne Basin estuarine system. Stone (2005) found that barrier islands serve to absorb wave energy during storms and fair-weather conditions, thereby provide some storm surge protection for the interior marshes within the basin, which would decrease land loss erosion rates substantially.

The continued loss of the Terrebonne barrier islands would also work synergistically, to some unknown extent, with increased channelization in nearby mainland estuarine marshes with previously low drainage densities which could allow: 1) the more efficient penetration of salt water into areas previously isolated from direct exchanges, and 2) increase in tidal flows which are thought by some to enhance erosion of some marsh types (Stevenson et al. 1985; Gagliano et al. 1981). Indirect effects of channelization could also include a further loss of mainland wetlands by erosion of canal banks subsequent to dredging (Gosselink and Sasser, 1995).

5.2.1.1.3 Cumulative

Natural and human-induced changes to coastal processes throughout coastal Louisiana has resulted in the loss of approximately 1,900 square miles of coastal wetland resources since the 1930's (Dunbar et al. 1992; Barras et al. 1994; Barras et al. 2003). Natural and human-induced changes to coastal processes, if left unchecked, would result in the loss of approximately 10 percent of Louisiana's remaining coastal wetlands at a rate of approximately 6,600 acres per year over the next 50 years. This would result in an additional net loss of 328,000 acres by 2050 (Barras et al. 2003). If the natural and human-induced changes to coastal process responsible for continued land loss continue in the Study Area, the Terrebonne Basin barrier island system would likely continue to be lost at rates similar to present resulting in the projected loss over all seven of the Terrebonne barrier islands of about 3,220 acres by 2062. This projected loss of barrier island soil resources would be in addition to the projected loss of barrier resources throughout coastal Louisiana.

The LCA Study (USACE, 2004) estimated coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year over the next 50 years. Cumulative impacts would be the synergistic effect of the No-Action Alternative on coastal processes of flows and water levels with the additive combination of similar barrier system degradation and barrier island loss impacts to flow and water levels throughout coastal Louisiana, as well as the benefits and impacts of other State and Federal projects in the vicinity.

5.2.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.2.1.2.1 Direct

Compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would restore a total of 5,840 acres on Raccoon, Timbalier, Trinity, and Whiskey Islands. This action would restore these barrier islands to their minimal geormorphological form thereby enabling, consistent with Stone (2005), these barrier islands to absorb wave energy during storms and fair-weather conditions and provide some storm surge protection for the interior marshes within the basin, which would decrease land loss erosion rates.

Additional direct impacts would be related to hydrologic connectivity between the barrier island restoration sites, the Gulf of Mexico (GOM), and surrounding bays which would be temporarily disrupted by the construction of retention dikes for beach, dune and marsh restoration. However, retention dikes would be designed to naturally degrade following completion of construction thereby restoring hydrologic connectivity with GOM and surrounding bays.

5.2.1.2.2 Indirect

Compared to the No Action Alternative, indirect impacts of restoring 2,781 net acres of barrier habitats by implementing Alternative 5 (NER Plan) would reduce (consistent with Stone (2005)), to some undetermined level, potential adverse impacts associated with increased storm surge and wave potential to the Terrebonne basin interior estuarine wetlands. The existing segmented breakwaters on Raccoon Island would continue to reduce storm wave action, which would encourage deposition of suspended sediments behind these features. The 1,200-ft long terminal groin on Raccoon Island would intercept the net longshore sediment flux, thereby retaining sediment on the beach up-drift of the groin. The terminal groin would reduce longshore erosion by capturing sediments that would otherwise be lost through offshore transport and deposition.

Wave Conditions

Impacts of sand mining on wave transformation over Ship Shoal was investigated by Stone and Xu (1996) and Stone (2000) and reported in MMS (2004). Stone and Xu (1996) conducted a wave modeling analysis using STWAVE to evaluate the effects of large-scale removal of sand from various portions of Ship Shoal. The approach used in the 1996 study centered on the removal of the entire shoal complex using the available bathymetric data for the shoal and surrounding area. The total volume of sand numerically extracted from the shoal for the modeling analysis was over 1.4 billion cy which included up to a 6-meter thick section of sand being removed from the western portion of the shoal.

The STWAVE model analysis conducted by Stone and Xu (1996) indicated spatial differences in the magnitude of wave heights across the Ship Shoal. The magnitude in wave heights due to shoal removal were less on the east side of the shoal compared to the west side. Wave height changes on the east side of the shoal were reported to be insignificant during severe storms and even less noticeable under fair weather conditions. During severe storm conditions, the model indicated wave breaking does not occur on the east end of the shoal near South Pelto Blocks 12 and 13 because of the greater water depths. The STWAVE results did show some increased wave heights in the central and western portions of the shoal but the overall model results indicated that the entire removal of the shoal would not have a significant impact on wave energy conditions along the nearshore zone (MMS 2004).

A subsequent study by Stone et al. (2009) investigated the impacts of sand mining on hydrodynamics and sediment transport on Ship Shoal using two case studies. Case study A compared the hydrodynamics of the region under two bathymetric configurations: one with the shoal and the other with the shoal completely removed. Case study B utilized four different sand mining scenarios which mimicked proposed restoration project borrow area configurations (Table 5-3). Specifically, they examined wave, current variability, and sediment transport over the shoal under different barrier island restoration/mining scenarios under a winter storm and tropical cyclone event (Table 5-2). The researchers looked at mining at three areas of Ship Shoal, namely, South Pelto Block 12/13, SS Block 88/89, and SS Blocks 84/85/98/99.

Table 5-3. Ship Shoal mining scenarios (Stone et al. 2009).

Ship Shoal sand mining scenarios.

Case	Sand volume ($x\ 10^6\ m^3$)	Mining area	Excavation depth (m)	Restoration target
B-1	7.65	A	0.24 m	Caminada
B-2	13.76	A	0.43 m	Caminada, Whiskey/Trinity
B-3	6.12	B	0.21 m	Wiskey/Trinity Islands
B-4	9.18	B	0.31 m	Entire Isles Dernieres
B-5	9.18	C	0.37 m	Entire Isles Dernieres

Table 5-4. Maximal difference in magnitude of hydrodynamic parameters between actual bathymetry and hypothetical bathymetry. Top low; Maximal difference in absolute magnitude of each parameter. Bottom low: Maximal values in magnitude of each parameter during model duration (Stone et al. 2009).

Storm	Case	Wave height	Surface currents (m/s)	Bottom currents (m/s)	RI N m-2
Winter storms	B2	0.09 1.19	0.17 0.59	0.03 0.20	0.02 0.82
	B4	0.04 1.30	0.11 0.49	0.06 0.15	0.02 0.62

Storm	Case	Wave height	Surface currents (m/s)	Bottom currents (m/s)	RI N m-2
	B5	0.03 1.67	0.16 0.10	0.06 0.10	0.02 0.60
Hurricane Lili	B2	0.07 1.52	0.09 0.97	0.04 0.33	0.01 1.10
	B4	0.04 2.06	0.15 0.75	0.07 0.22	0.08 1.16
	B5	0.07 3.47	0.05 0.06	0.03 0.15	0.04 1.39

Stone et al.'s (2009) modeling results indicate that Ship Shoal has significant influence on wave dissipation but suggest that neither large-scale nor small-scale sand mining should result in abrupt changes in current patterns. The results indicate that large-scale sand dredging would have profound impact on waves as shown on Figure 5-1 as well as on sediment suspension. Based on this analysis, large scale mining of Ship Shoal is not recommended. However, Stone et al.'s (2009) results indicate that small-scale sand mining, based on the sand mining scenarios presented in Table 5-3, is not expected to profoundly impact hydrodynamics or sediment transport over Ship Shoal.

Implementing Alternative 5 (NER Plan) would restore a portion of the natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur) thereby reducing, to some unknown extent, the annual economic loss to Louisiana and the nation (after Van Heerden and DeRouen 1997). Furthermore, the proposed barrier shoreline restoration would contribute to the "Cajun" culture and its people thereby indirectly impacting the State's economy and advancing by some unknown extent, the economic development of the State of Louisiana.

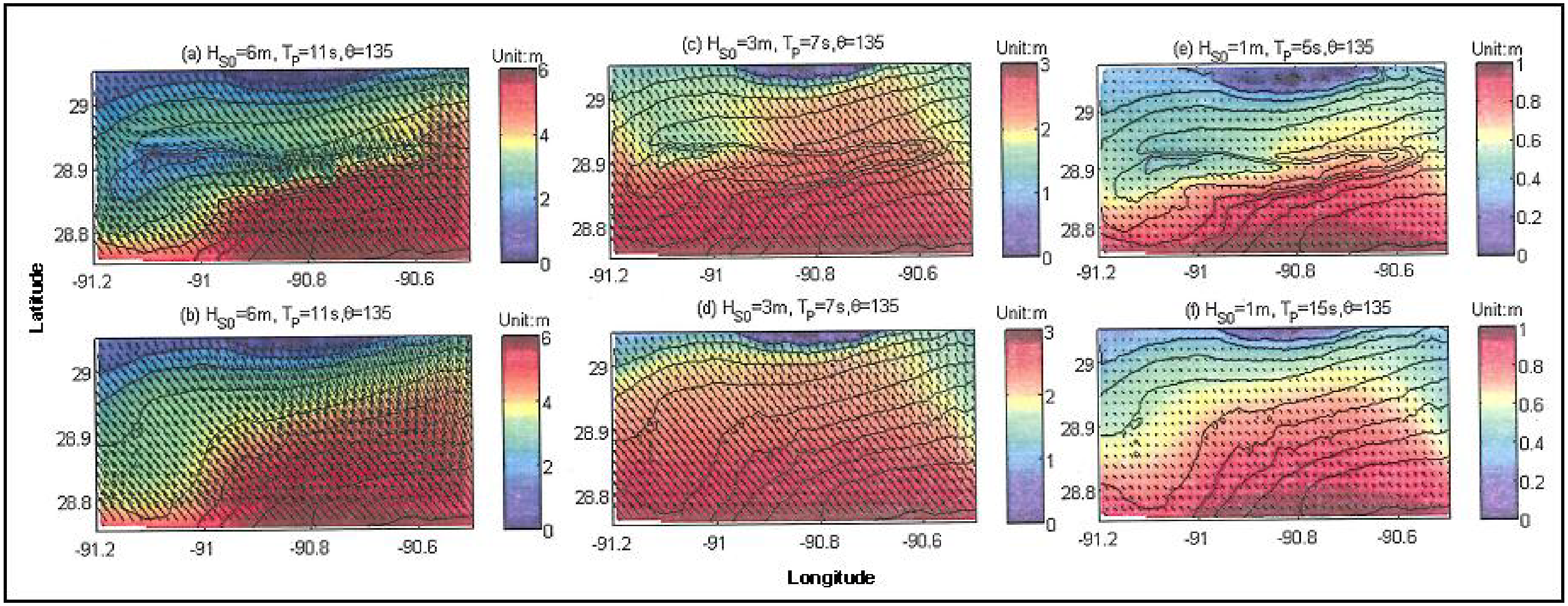

Figure 5-1. Wave height and vector distributions for case Study A: (a, b) H_S=6m, T_P =11s, Wave direction=135 (degree). (c,d) H_S=3m, T_P =7s, Wave direction=135 (degree), (e,f) H_S=1m, T_P =5s, Wave direction=135 (degree). Top figures represent the results with the shoal and bottom figures represent the result without the shoal (Stone et al. 2009).

5.2.1.2.3 Cumulative

Cumulative impacts would be the incremental impacts to coastal processes, flow and water levels from implementing Alternative 5 (NER Plan) when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 5 (NER Plan) would restore the geomorphologic form and ecological function to a net total of 2,781 acres of Terrebonne barrier island resources. Restoration of the geomorphologic form to Raccoon, Whiskey, Trinity and Timbalier Islands would, consistent with Stone (2005), enable these barrier islands to maintain their function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes, which would decrease interior land loss erosion rates. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area.

The existing segmented breakwaters on Raccoon Island, in combination with other existing breakwaters such as those at Port Fouchon, Louisiana, would continue to reduce storm wave action, thereby enabling the deposition of suspended sediments behind these features.

The proposed 1,200-ft long terminal groin on the west end of Raccoon Island would intercept the net longshore sediment flux, thereby retaining sediments on the beach up-drift of the groin. The proposed terminal groin on the west end of Raccoon Island would complement the proposed CWPPRA TE-48 terminal groin on the east end of Raccoon Island.

The incremental impacts of implementing Alternative 5 (NER Plan) would be in synergistic combination to impacts and benefits for overall net acres of barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.2.1.3 Alternative 11: Whiskey (Plan C)

5.2.1.3.1 Direct

Compared to the No Action Alternative, direct impacts to coastal processes, flows and water levels of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), but to a much lesser degree. Alternative 11 would restore the geomorphologic form and ecological function to Whiskey Island resulting in an initial island of 1,272 acres.

5.2.1.3.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) but to a lesser degree. Alternative 11 would restore a net total of 527 acres of barrier island habitat. Consistent with Stone (2005), restoration of Whiskey Island would absorb wave energy during storms and fair-weather conditions and provide some storm surge protection, but to a much lesser degree than Alternative 5 (NER Plan) for the Terrebonne basin interior estuarine wetlands. The interior land loss erosion rates would see a similarly less proportional decrease as compared to Alternative 5 (NER Plan).

5.2.1.3.3 Cumulative

Cumulative impacts of implementing Alternative 11 to coastal processes, flow and water levels would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) but to a much lesser degree for restoration of a net total of 527 acres. The incremental impacts of implementing Alternative 11 would be in synergistic combination to impacts and benefits for overall net acres of barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.2.1.4 Alternative 2: Timbalier (Plan E)

5.2.1.4.1 Direct

Compared to the No Action Alternative, direct impacts to coastal processes, flows and water levels of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan), but to a much lesser degree. Alternative 2 would restore the geomorphologic form and ecological function to Timbalier Island resulting in an initial island of 2,630 acres.

5.2.1.4.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) but to a lesser degree. Alternative 2 would restore a net total of 1,324 acres of barrier island habitat. Consistent with Stone (2005), restoration of Timbalier Island would absorb wave energy during storms and fair-weather conditions and provide some storm surge protection, but to a much lesser degree than Alternative 5 (NER Plan) for the Terrebonne basin interior estuarine wetlands. The interior land loss erosion rates would see a similarly less proportional decrease as compared to Alternative 5 (NER Plan).

5.2.1.4.3 Cumulative

Cumulative impacts of implementing Alternative 2 to coastal processes, flow and water levels would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) but to a much lesser degree for restoration of a net total of 1,324 acres. The incremental impacts of implementing Alternative 2 would be in synergistic combination to impacts and benefits for overall net acres of barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.2.1.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.2.1.5.1 Direct

Compared to the No Action Alternative, direct impacts to coastal processes, flows and water levels of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan), but to a much lesser degree. Alternative 3 would initially restore the geomorphologic form and ecological function to a 1,272-acre Whiskey Island and 2,630-acre Timbalier Island.

5.2.1.6 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) but to a lesser degree. Alternative 3 would restore a net total of 1,851 acres of barrier island habitat. Consistent with Stone (2005), restoration of Whiskey and Timbalier Islands would absorb wave energy during storms and fair-weather conditions and provide some storm surge protection, but to a lesser degree than Alternative 5 (NER Plan) for the Terrebonne basin interior estuarine wetlands. The interior land loss erosion rates would see a similarly less proportional decrease as compared to Alternative 5 (NER Plan).

5.2.1.6.1 Cumulative

Cumulative impacts of implementing Alternative 3 to coastal processes, flow and water levels would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) but to a lesser degree with restoration of a net total of 1,851 acres of barrier island habitat. The incremental impacts of implementing Alternative 3 would be in synergistic combination to impacts and benefits for overall net acres of barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.2.1.7 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.2.1.7.1 Direct

Compared to the No Action Alternative, direct impacts to coastal processes, flows and water levels of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan), but to a lesser degree. Alternative 4 would initially restore the geomorphologic form and ecological function to a 1,272-acre Whiskey Island, 1,149-acre Trinity Island and 2,630-acre Timbalier Island.

5.2.1.7.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) but to a lesser degree. Alternative 4 would restore a net total of 2,140 acres of barrier island habitat. Consistent with Stone (2005), restoration of Whiskey, Trinity and Timbalier Islands would absorb wave energy during storms and fair-weather conditions and provide some storm surge protection, but to a lesser degree than Alternative 5 (NER Plan) for the Terrebonne basin interior estuarine wetlands. The interior land loss erosion rates would see a similarly less proportional decrease as compared to Alternative 5 (NER Plan).

5.2.1.7.3 Cumulative

Cumulative impacts of implementing Alternative 4 to coastal processes, flow and water levels would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) but to a lesser degree with restoration of a net total of 2,140 acres of barrier island habitat. The incremental impacts of implementing Alternative 3 would be in synergistic combination to impacts and benefits for overall net acres of barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.2.2 Sediment and Erosion

5.2.2.1 No action Alternative (Future without Project Conditions)

5.2.2.1.1 Direct

Little information concerning sediment exchange between the Gulf of Mexico and the Terrebonne Basin coastal wetlands is available. Roberts et al. (1987) suggest that storm passage over the coastal boundary provides for accretion if there is a sediment supply offshore. However, if there is no sediment supply, erosion is likely to occur. Estuaries with large openings to the Gulf of Mexico contain higher percentages of sand and course silt than equally large bodies with no connection to the Gulf (Barret, 1971). The No Action Alternative would have no direct impacts on sedimentation and erosion. Without any action, approximately 3,220 acres of existing barrier sediment resources from the seven island Terrebonne Basin barrier system (East Timbalier, Timbalier, Trinity, East Island, Wine, Whiskey and Raccoon Island) would likely continue to erode similar to historic erosion rates (Table 4-2 and 4-3) and eventually convert into shallow open water bottoms. Sediments eroded from these barrier islands would be lost offshore.

5.2.2.1.2 Indirect

Under the No Action Alternative the Terrebonne Basin barrier islands would continue to erode and migrate (Williams et al. 1992). According to Hoyt and Henry (1967) sedimentary modifications produced by island migration would include textural changes, shape of the deposit, and steepening and reorientation of stratification. The re-working of sediments which accompany island migration could potentially alter the texture of sediment, depending on the material available for deposition and on the composition of the sediment being reworked. The primary impacts of barrier island migration would be modification of stratification.

According to Britton and Morton (1993), barrier islands such as the Terrebonne barrier system play an important role in defining the physical boundary between the marine and estuarine systems. Sandy beaches, composed of almost infinite numbers of particles, experience considerable wave exposure. The net transport of these particles is landward with constructive waves. Particles moved landward may be moved high upon the shore where they become soil stabilized by vegetation. Successive layers of the material accumulate until equilibrium with the topography is achieved. Britton and Morton (1993) indicate, however, that there is an energy threshold beyond which wave cease being constructive and become destructive on a soft shore. During storms, sediment is removed from a beach and dumped offshore. Destructive waves have relatively greater kinetic energy than constructive waves and sand particles are held in suspension longer, allowing backwash to remove at least some of them downshore.

Britton and Morton (1993) further indicate that the ultimate character of a soft shore, including its slope, stability and capacity as a habitat, is dependent upon the size and distribution of the particles that comprise it. On low energy mudflats, little sorting occurs; whereas, on high energy beaches sorting capacity is greatly enhanced. Additional sorting is achieved by the swash and backwash. On wave sorted beaches, the coarsest grains occur at the top of the beach and the finest at the bottom typically below low water.

Sediment quality is important due to the indirect role that sediments play in supporting animal and plant community productivity (LDEQ, 2005). The productivity of green plants, algae, and bacteria are the foundation of food webs upon which higher aquatic and terrestrial organisms depend (Day et al. 1989). Sediments provide essential habitats for epibenthic (organisms which live on sediments) and infaunal (organisms which live in sediments) invertebrates and demersal fish, which represent important food sources for amphibians, reptiles, fish, birds, and mammals (Britton and Morton 1993). In addition, many fish and amphibian species utilize sediments at stages in their life cycles for the purposes of spawning, incubation, refuge, and over-wintering (Day et al. 1989; Britton and Morton 1993; LDEQ, 2005).

Without any action, approximately 3,220 acres of existing barrier resources from the seven island Terrebonne Basin barrier system (East Timbalier, Timbalier, Trinity, East Island, Wine, Whiskey and Raccoon Island) would likely continue to degrade, fragment and eventually convert into shallow open water bottoms. The Terrebonne Basin barrier island system would continue to experience higher wave energy levels and associated shoreline erosion in the adjacent bays (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005).

If the Terrebonne Basin barrier island system is not restored, the adjacent estuarine bay systems, along with their sediment resources, will continue to be transformed into marine open water habitat. The loss of barrier resources would adversely impact important transitional habitat between estuarine and marine environments; essential fish habitat (EFH); unique wildlife habitat (e.g., nursery, nesting, feeding, and roosting habitats); and critical wintering habitat for the threatened piping plover. The continued degradation and eventual loss of soil resources would result in the loss of fish and wildlife habitat which would likely increase competition between and within various fish and wildlife species for diminishing habitat resources. The loss of vegetated wetlands would also result in a loss in primary productivity and eventually result in conversion of the existing back bay estuarine system into more marine open water system.

5.2.2.1.3 Cumulative

The No Action Alternative would have cumulative impacts on sediments and erosion in which sediment quality, quantity, and sediment source would be affected. Erosion rates would increase to the point that the barrier habitats would erode and sedimentation would decrease forcing these critical habitats to eventually no longer exist. Sediment quality, an important role that sediments play in supporting community productivity, would be altered in size and the availability of sediments that are needed for healthy marsh, beach, and dune habitats. When all intertidal habitats along the barrier islands disappear, the remaining habitat types will increase in erosion and disappear as well. Storm surge will then reach further inland with the absence of these barrier islands resulting in an increase in erosion along inland marshes.

5.2.2.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.2.2.2.1 Direct

Compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would initially restore Raccoon, Timbalier, Trinity, and Whiskey Islands to their minimal geormorphological form and ecological function utilizing approximately 67,184,714 cy of borrow sediments obtained from several sources, including Ship Shoal, Raccoon, Whiskey 3a, South Pelto, and New Cut. Borrow sediments from the South Pelto borrow area are characterized as D50 grain size 0.15 to 0.2 mm, with less than 5% silt in upper stratigraphic layer. Other borrow area sediments would be comparable. Impacts to sediments and erosion would primarily be indirect.

5.2.2.2.2 Indirect

Compared to the No Action Alternative, indirect impacts of restoring 2,781 net acres of barrier habitats by implementing Alternative 5 (NER Plan) would be related to the geomorphologic character of the restored barrier islands. Indirect impacts to sediments and erosion would be primarily related to size and distribution of sediment particles.

Following construction, sediments would continue to be subjected to high energy wave sorting as well as additional sorting achieved by the swash and backwash. The coarsest sediment grains would occur at the top of the beach and the finest at the bottom typically below low water. Erosion rates (Tables 4-2 and 4-3), adapted from Williams et al. (1992), where calculated for each barrier island component within Alternative 5 (NER Plan). Erosive forces, such as waves and storms, would continue. However, the coarser grained borrow sediments would be expected to better withstand erosive forces (personal communication Dr. Louis "Del" Britsch, USACE Geologist, 1 September 2010). Restoration of fragmented beach and dune would reduce erosion of the back barrier marsh. In addition, restoration with the higher quality borrow sediments would enable, consistent with Stone (2005), the restored barrier islands to better absorb wave energy during storms and fair-weather conditions and provide some storm surge protection for the interior marshes within the basin, which would decrease land loss erosion rates.

The character of the restored barrier islands, including their slope, stability and capacity as a habitat, would be dependent upon the size and distribution of the sediment particles that comprise it. A portion of the total 67,184,714 cy of borrow sediments placed for restoration of the four barrier islands would be redistributed, via natural coastal longshore transport process, throughout the Terrebonne barrier island system over the 50-year period of analysis.

The proposed terminal groin, as well as the existing segmented breakwaters, on Raccoon Island would function to intercept the net longshore sediment flux, thereby retaining sediments on the beach up-drift of the groin and within the tombolos shoreward of the breakwaters. Sedimentation rates along Whiskey, Trinity and Timbalier Islands would likely remain unchanged.

Implementing Alternative 5 (NER Plan) would restore a portion of the natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur) thereby reducing, to some unknown extent, the annual economic loss to Louisiana and the nation (after Van Heerden and DeRouen 1997). Furthermore, the proposed barrier shoreline restoration would contribute to the "Cajun" culture and its people thereby indirectly impacting the State's economy and advancing by some unknown extent, the economic development of the State of Louisiana.

5.2.2.2.3 Cumulative

Cumulative impacts would be the incremental impacts to sediment and erosion from implementing Alternative 5 (NER Plan) when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 5 (NER Plan) would restore the geomorphologic form and ecological function to a net total of 2,781 acres of Terrebonne barrier island resources. Restoration of the geomorphologic form to these four barrier islands would, consistent with Stone (2005), enable these barrier islands to maintain their function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes, which would decrease interior land loss erosion rates. These incremental impacts would be in addition to impacts and benefits for acres of barrier islands created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.2.2.3 Alternative 11: Whiskey (Plan C)

5.2.2.3.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan). Whiskey Island would be restored to its minimal geormorphological form and ecological function utilizing approximately 26,660,249 cy of borrow sediments obtained from several sources, including Ship Shoal and Whiskey borrow areas.

5.2.2.3.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER) but to a lesser degree, including the natural redistribution of a portion of the total 23,599,804 cy of sediments throughout the Terrebonne Basin barrier island system over the 50-year period of analysis. The coarser grained borrow sediments would be expected to better withstand erosive forces (personal communication Dr. Louis “Del” Britsch, USACE Geologist, September 1, 2010). In addition, restoration of fragmented beach and dune on Whiskey Island would reduce erosion of the back barrier marsh.

Consequently, restoration with the higher quality borrow sediments would enable, consistent with Stone (2005), the restored Whiskey Island to better absorb wave energy during storms and fair-weather conditions and provide some storm surge protection for the interior marshes within the basin, which would decrease land loss erosion rates, although to a much less extent than Alternative 5 (NER Plan). Additional indirect impacts would be the prevention of a net total of 527 acres of barrier habitats and associated sediments being lost to erosion and converting to water bottoms over the 50-year period of analysis.

5.2.2.3.3 Cumulative

Cumulative impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the natural redistribution of a portion of the 26,940,240 cy of sediments throughout the Terrebonne Basin barrier island system as well as the prevention of a net total of 527 acres of barrier sediments being lost to erosion and conversion to water bottoms over the 50-year period of analysis. These incremental cumulative impacts of Alternative 11 would be in addition to impacts and benefits to sediment and erosion for barrier islands created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.2.2.4 Alternative 2: Timbalier (Plan E)

5.2.2.4.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan). Timbalier Island would be restored to its minimal geomorphologic form and ecological function utilizing approximately 20,246,338 cy of sediments be removed from South Pelto – 6, Whiskey – 3, and New Cut – 5 borrow areas.

5.2.2.4.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) but to a lesser degree, including the natural redistribution of a portion of the total 20,246,338 cy of sediments throughout the Terrebonne Basin barrier island system over the 50-year period of analysis. Additional indirect impacts would be the prevention of a net total of 1,324 acres of barrier habitats and associated sediments being lost to erosion and converting to water bottoms over the 50-year period of analysis. The coarser grained borrow sediments would be expected to better withstand erosive forces (personal communication Dr. Louis “Del” Britsch, USACE Geologist, September 1, 2010). In addition, restoration of fragmented beach and dune on Whiskey Island would reduce erosion of the back barrier marsh.

Consequently, restoration with the higher quality borrow sediments would enable, consistent with Stone (2005), the restored Whiskey Island to better absorb wave energy during storms and fair-weather conditions and provide some storm surge protection for the interior marshes within the basin, which would decrease land loss erosion rates, although to a much less extent than Alternative 5 (NER Plan). Additional indirect impacts would be the prevention of a net total of 1,324 acres of barrier habitats and associated sediments being lost to erosion and converting to water bottoms over the 50-year period of analysis.

5.2.2.4.3 Cumulative

Compared to the No Action Alternative, indirect impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) including the natural redistribution of a portion of the 20,246,338 cy of sediments throughout the Terrebonne Basin barrier island system as well as the prevention of a net total of 1,324 acres of barrier sediments being lost to erosion and conversion to water bottoms over the 50-year period of analysis. These incremental cumulative impacts would be in addition to impacts and benefits to sediment and erosion for barrier islands created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.2.2.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.2.2.5.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan). Whiskey and Timbalier Islands would be restored to their minimal geomorphologic form and ecological function utilizing a total of approximately 43,846,142 cy of sediments removed from Ship Shoal, South Pelto, Whiskey 3a, and New Cut borrow areas.

5.2.2.5.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER) but to a lesser degree, including the natural redistribution of a portion of the total 43,846,142 cy of sediments throughout the Terrebonne Basin barrier island system over the 50-year period of analysis. Additional indirect impacts would be the prevention of a net total of 1,851 acres of barrier habitats and associated sediments being lost to erosion and converting to water bottoms over the 50-year period of analysis. The coarser grained borrow sediments would be expected to better withstand erosive forces (personal communication Dr. Louis “Del” Britsch, USACE Geologist, September 1, 2010). In addition, restoration of fragmented beach and dune on Whiskey and Timbalier Islands would reduce erosion of the back barrier marsh for these islands.

Consequently, restoration with the higher quality borrow sediments would enable, consistent with Stone (2005), the restored Whiskey and Timbalier Islands to better absorb wave energy during storms and fair-weather conditions and provide some storm surge protection for the interior marshes within the basin, which would decrease land loss erosion rates, although to a much less extent than Alternative 5 (NER Plan). Additional indirect impacts would be the prevention of a net total of 1,851 acres of barrier habitats and associated sediments being lost to erosion and converting to water bottoms over the 50-year period of analysis.

5.2.2.5.3 Cumulative

Compared to the No Action Alternative, indirect impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) including the natural redistribution of a portion of the 43,846,142 cy of sediments throughout the Terrebonne Basin barrier island system as well as the prevention of a net total of 1,851 acres of barrier sediments being lost to erosion and conversion to water bottoms over the 50-year period of analysis. These incremental cumulative impacts would be in addition to impacts and benefits to sediment and erosion for barrier islands created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.2.2.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.2.2.6.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan). Whiskey, Trinity and Timbalier Islands would be restored to their minimal geomorphologic form and ecological function utilizing a total of approximately 55,246,837 of sediments removed from Ship Shoal, South Pelto, Whiskey 3a, Raccoon Island, and New Cut – 5 borrow areas.

5.2.2.6.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity, and Timbalier Islands components of Alternative 5 (NER Plan) but to a lesser degree, including the natural redistribution of a portion of the total 55,246,837 cy of sediments throughout the Terrebonne Basin barrier island system over the 50-year period of analysis. Additional indirect impacts would be the prevention of a net total of 2,140 acres of barrier habitats and associated sediments being lost to erosion and converting to water bottoms over the 50-year period of analysis. The coarser grained borrow sediments would be expected to better withstand erosive forces (personal communication Dr. Louis "Del" Britsch, USACE Geologist, September 1, 2010). In addition, restoration of fragmented beach and dune on Whiskey, Trinity and Timbalier Islands would reduce erosion of the back barrier marsh for these islands.

Consequently, restoration with the higher quality borrow sediments would enable, consistent with Stone (2005), the restored Whiskey, Trinity and Timbalier Islands to better absorb wave energy during storms and fair-weather conditions and provide some storm surge protection for the interior marshes within the basin, which would decrease land loss erosion rates, although to a much less extent than Alternative 5 (NER Plan). Additional indirect impacts would be the prevention of a net total of

2,140 acres of barrier habitats and associated sediments being lost to erosion and converting to water bottoms over the 50-year period of analysis.

5.2.2.6.3 Cumulative

Compared to the No Action Alternative, indirect impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) including the natural redistribution of a portion of the 55,246,837 cy of sediments throughout the Terrebonne Basin barrier island system as well as the prevention of a net total of 2,140 acres of barrier sediments being lost to erosion and conversion to water bottoms over the 50-year period of analysis. These incremental cumulative impacts would be in addition to impacts and benefits to sediment and erosion for barrier islands created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.2.3 Water Use and Supply

5.2.3.1 No action Alternative (Future without Project Conditions)

5.2.3.1.1 Direct

The Study Area is remote and uninhabited. Hence, there would be no direct impacts of the No Action Alternative on water use and supply. Not implementing the Terrebonne Basin barrier island restoration would result in the persistence of existing conditions.

5.2.3.1.2 Indirect

There would be no indirect impacts of the No Action Alternative on the water use and supply within the Study Area.

5.2.3.1.3 Cumulative

There would be no cumulative impacts of the No Action Alternative on water use and supply within the Study Area.

5.2.3.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.2.3.3

5.2.3.3.1 Direct

There would be no direct impact on the water supplies in this area.

5.2.3.3.2 Indirect

There would be no indirect impact on the water supplies in this area.

5.2.3.3.3 Cumulative

There would be no cumulative impact on the water supplies in this area.

5.2.3.4 Alternative 11: Whiskey (Plan C)

5.2.3.4.1 Direct

There would be no direct impact on the water supplies in this area.

5.2.3.4.2 Indirect

There would be no indirect impact on the water supplies in this area.

5.2.3.4.3 Cumulative

There would be no cumulative impact on the water supplies in this area.

5.2.3.5 Alternative 2: Timbalier (Plan E)

5.2.3.5.1 Direct

There would be no direct impact on the water supplies in this area.

5.2.3.5.2 Indirect

There would be no indirect impact on the water supplies in this area.

5.2.3.5.3 Cumulative

There would be no cumulative impact on the water supplies in this area.

5.2.3.6 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.2.3.6.1 Direct

There would be no direct impact on the water supplies in this area.

5.2.3.6.2 Indirect

There would be no indirect impact on the water supplies in this area.

5.2.3.6.3 Cumulative

There would be no cumulative impact on the water supplies in this area.

5.2.3.7 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.2.3.7.1 Direct

There would be no direct impact on the water supplies in this area.

5.2.3.7.2 Indirect

There would be no indirect impact on the water supplies in this area.

5.2.3.7.3 Cumulative

There would be no cumulative impact on the water supplies in this area.

5.2.4 Groundwater

5.2.4.1 No action Alternative (Future without Project Conditions)

5.2.4.1.1 Direct

The Study Area is remote and uninhabited. Hence, there would be no direct impacts of the No Action Alternative on groundwater. Not implementing barrier restoration features would result in the persistence of existing conditions.

5.2.4.1.2 Indirect

There would be no indirect impact on the groundwater in the Study Area.

5.2.4.1.3 Cumulative

There would be no cumulative impact on the groundwater supplies in the Study Area.

5.2.4.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.2.4.2.1 Direct

There would be no direct impact on the groundwater in the Study Area.

5.2.4.2.2 Indirect

There would be no indirect impact on the groundwater in the Study Area.

5.2.4.2.3 Cumulative

There would be no cumulative impact on the groundwater supplies in the Study Area.

5.2.4.3 Alternative 11: Whiskey (Plan C)

5.2.4.3.1 Direct

There would be no direct impact on the groundwater in the Study Area.

5.2.4.3.2 Indirect

There would be no indirect impact on the groundwater in the Study Area.

5.2.4.3.3 Cumulative

There would be no cumulative impact on the groundwater supplies in the Study Area.

5.2.4.4 Alternative 2: Timbalier (Plan E)

5.2.4.4.1 Direct

There would be no direct impact on the groundwater in the Study Area.

5.2.4.4.2 Indirect

There would be no indirect impact on the groundwater in the Study Area.

5.2.4.4.3 Cumulative

There would be no cumulative impact on the groundwater supplies in the Study Area.

5.2.4.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.2.4.5.1 Direct

There would be no direct impact on the groundwater in the Study Area.

5.2.4.5.2 Indirect

There would be no indirect impact on the groundwater in the Study Area.

5.2.4.5.3 Cumulative

There would be no cumulative impact on the groundwater supplies in the Study Area.

5.2.4.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.2.4.6.1 Direct

There would be no direct impact on the groundwater in the Study Area.

5.2.4.6.2 Indirect

There would be no indirect impact on the groundwater in the Study Area.

5.2.4.6.3 Cumulative

There would be no cumulative impact on the groundwater supplies in the Study Area.

5.3 Water Quality and Salinity

5.3.1 Water Quality

5.3.1.1 No action Alternative (Future without Project Conditions)

5.3.1.1.1 Direct

The No Action Alternative, not implementing the Terrebonne Basin Barrier Shoreline restoration, would have no direct impact on water quality resources. Existing conditions would likely continue into the future.

5.3.1.1.2 Indirect

Without implementation of the Terrebonne Basin Barrier Shoreline restoration, the Terrebonne Basin would still be affected by natural and anthropogenic activities having both beneficial and detrimental effects to water quality. Some of these activities include: other restoration efforts, including other CWPPRA, USACE, NRCS, and LDNR projects; Federal and State water quality management programs; programs addressing hypoxia in the northern Gulf of Mexico; the continuation of erosion and subsidence of coastal Louisiana; oil and gas development; and Federal, State, and municipal flood-damage reduction and navigation projects. The future of water quality for coastal Louisiana is dependent on a responsible, watershed approach to managing these activities.

5.3.1.1.3 Cumulative

A majority of the present and future activities would persist without the Terrebonne Basin Barrier Shoreline restoration and would affect surface water quality conditions throughout Louisiana. The cumulative impacts associated with these activities without the Terrebonne Basin Barrier Shoreline restoration are included below:

Passage of the Federal Water Pollution Control Act (FWPCA) in 1948 and its amendments, including the CWA and the Water Quality Act of 1987, as well as the establishment of State and Federal environmental protection agencies, resulted in water pollution control regulations, including:

- The National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution. In 1997 the USEPA granted NPDES delegation to the Louisiana Department of Environmental Quality (LDEQ), which is known as the Louisiana Pollutant Discharge Elimination System (LPDES).

- The LDEQ Nonpoint Source Pollution Program is continuing to implement watershed initiatives to address nonpoint source pollution sources such as agriculture, home sewage treatment, hydromodification, urban runoff, construction activities, and resource extraction.

- The LDNR's Coastal Nonpoint Pollution Program is responsible for identifying Best Management Practices (BMPs) appropriate for all applicable pollutant source categories and carrying out initiatives of public education, technical assistance, and development of enforcement protocols.

- Total Maximum Daily Loads (TMDLs); Section 303(d) of the CWA requires states to identify, list, and rank for development of TMDLs for waters that do not meet applicable water quality standards after implementation of technology-based controls.

- The Barataria-Terrebonne National Estuary Program (BTNEP) is a coalition of government, private, and commercial interests active in collecting/publishing information, as well as educating the public to protect the Barataria and Terrebonne Basins.

- The USEPA-formed Hypoxia Task Force is leading a national task force to address hypoxia in the northern Gulf of Mexico, which is attributed to the excessive nutrients in the Mississippi – Atchafalaya River Basin.

These programs would continue to develop with or without the Terrebonne Basin Barrier Shoreline restoration to ensure that Louisiana public health and natural resources remain protected. With these programs in place, it is expected that water quality conditions within the State of Louisiana would likely improve overall. However, activities with the potential for negative effects on water quality would also continue to occur with or without the proposed restoration features. In addition, present and future Federal, State, local, and private ecosystem restoration projects would probably improve water quality conditions throughout Louisiana.

5.3.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.3.1.2.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 5 (NER Plan) would primarily result from the discharge of 67,184,714 cy of dredged material and associated effluent waters during construction. Proposed restoration features would not result in either long-term or short-term water quality impacts to the adjacent aquatic ecosystem. Potential impacts of dredged material effluent discharges would include increased turbidity and decreased oxygen concentrations, are expected to be short-lived and would likely result in temporary and minor impacts to water quality, if any.

5.3.1.2.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 5 (NER Plan) would result in minor improvements to water quality as barrier wetlands would serve as natural filters for improving water quality (Day et al. 1989). A net total of 1,459 acres of vegetated barrier habitats would be restored/created that would contribute to improving water quality. In addition, restoration of the four islands within the Terrebonne Basin barrier island system that would provide a more robust marine-estuarine geomorphic boundary that would contribute to restricting higher salinity Gulf of Mexico waters from entering fresher interior estuarine areas thereby helping stabilize salinity regimes in the lower portions of the Terrebonne Basin.

Implementing Alternative 5 (NER Plan) would restore a portion of the natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur) thereby reducing, to some unknown extent, the annual economic loss to Louisiana and the nation (after Van Heerden and DeRouen 1997). Furthermore, the proposed barrier shoreline restoration would contribute to the "Cajun" culture and its people thereby indirectly impacting the State's economy and advancing by some unknown extent, the economic development of the State of Louisiana.

5.3.1.2.3 Cumulative

Compared to the No Action Alternative, cumulative impacts of implementing Alternative 5 (NER Plan) would contribute towards the restoration of the Terrebonne Basin barrier system which would serve, in part, to protect coastal wetland areas from erosive forces. Restoring four of the seven Terrebonne Basin barrier islands would contribute to improving water quality within lower portions of the Terrebonne Basin.

Working synergistically with other restoration efforts (e.g., CWPPRA projects, LCA Convey Atchafalaya River water to northern Terrebonne marshes, and others) Alternative 5 (NER Plan) would contribute, to some unknown extent, to the stabilization of the marine – estuarine system and salinity regimes within the lower Terrebonne Basin. Stabilizing salinity regimes would contribute to multiple natural resource users, resource managers, commercial and recreational fisheries managers, and other water users in making long-term water quality management decisions.

The incremental impacts of implementing Alternative 5 (NER Plan) would be in synergistic combination to water quality impacts and benefits for overall net acres of barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.3.1.3 Alternative 11: Whiskey (Plan C)

5.3.1.3.1 Direct

Compared to the No Action Alternative, direct impacts water quality of implementing Alternative 11 would be similar, but to a much lesser degree, to those described for the Whiskey Island component of Alternative 5 (NER Plan). The discharge of 23,599,804 cy of dredged material and associated effluent waters during construction would include increased turbidity and decreased oxygen concentrations, which are expected to be short-lived and would likely result in temporary and minor impacts to water quality, if any.

5.3.1.3.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) but to a lesser degree. A net total of 311 acres of vegetated barrier habitats would be restored/created that would contribute to improving water quality as well as contribute to developing a more robust Terrebonne Basin barrier island system, provide a more robust marine-estuarine geomorphic boundary, and contribute to restricting higher salinity Gulf of Mexico waters from entering fresher interior estuarine areas thereby helping stabilize salinity regimes in the lower portions of the Terrebonne Basin.

5.3.1.3.3 Cumulative

Compared to the No Action Alternative, the incremental cumulative impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) but to a lesser degree. These impacts would contribute to improving water quality within lower portions of the Terrebonne Basin, work synergistically with other restoration efforts contributing to the stabilization of the marine – estuarine system and salinity regimes within the lower Terrebonne Basin. The incremental impacts of implementing Alternative 11 would be in synergistic combination to water quality impacts and benefits for overall net acres of barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.3.1.4 Alternative 2: Timbalier (Plan E)

5.3.1.4.1 Direct

Compared to the No Action Alternative, direct impacts water quality of implementing Alternative 2 would be similar, but to a much lesser degree, to those described for the Timbablier Island component of Alternative 5 (NER Plan). The discharge of 20,246,338 cy of dredged material and associated effluent waters during construction would include increased turbidity and decreased oxygen concentrations, which are expected to be short-lived and would likely result in temporary and minor impacts to water quality, if any.

5.3.1.4.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 2 (first component of construction) would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) but to a lesser degree. A net total of 706 acres of vegetated barrier habitats would be restored/created that would contribute to improving water quality as well as contribute to developing a more robust Terrebonne Basin barrier island system, provide a more robust marine-estuarine geomorphic boundary, and contribute to restricting higher salinity Gulf of Mexico waters from entering fresher interior estuarine areas thereby helping stabilize salinity regimes in the lower portions of the Terrebonne Basin.

5.3.1.4.3 Cumulative

Compared to the No Action Alternative, the incremental cumulative impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) but to a lesser degree. These impacts would contribute to improving water quality within lower portions of the Terrebonne Basin, work synergistically with other restoration efforts contributing to the stabilization of the marine – estuarine system and salinity regimes within the lower Terrebonne Basin. The incremental impacts of implementing Alternative 2 would be in synergistic combination to water quality impacts and benefits for overall net acres of barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.3.1.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.3.1.5.1 Direct

Compared to the No Action Alternative, direct impacts water quality of implementing Alternative 3 would be similar, but to a much lesser degree, to those described for the Whiskey and Timbablier Islands components of Alternative 5 (NER Plan). The discharge of 43,846,142 cy of dredged material and associated effluent waters during construction would include increased turbidity and decreased oxygen concentrations, which are expected to be short-lived and would likely result in temporary and minor impacts to water quality, if any.

5.3.1.5.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) but to a lesser degree. A net total of 1,017 acres of vegetated barrier habitats would be restored/created that would contribute to improving water quality as well as contribute to developing a more robust Terrebonne Basin barrier island system, provide a more robust marine-estuarine geomorphic boundary, and contribute to restricting higher salinity Gulf of Mexico waters from entering fresher interior estuarine areas thereby helping stabilize salinity regimes in the lower portions of the Terrebonne Basin.

5.3.1.5.3 Cumulative

Compared to the No Action Alternative, the incremental cumulative impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) but to a lesser degree. These impacts would contribute to improving water quality within lower portions of the Terrebonne Basin, work synergistically with other restoration efforts contributing to the stabilization of the marine – estuarine system and salinity regimes within the lower Terrebonne Basin. The incremental impacts of implementing Alternative 3 would be in synergistic combination to water quality impacts and benefits for overall net acres of barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.3.1.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.3.1.6.1 Direct

Compared to the No Action Alternative, direct impacts water quality of implementing Alternative 4 would be similar, but to a lesser degree, to those described for the Whiskey, Trinity and Timbablier Islands components of Alternative 5 (NER Plan). The discharge of 55,246,837 cy of dredged material and associated effluent waters during construction would include increased turbidity and decreased oxygen concentrations, which are expected to be short-lived and would likely result in temporary and minor impacts to water quality, if any.

5.3.1.6.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) but to a lesser degree. A net total of 1,12 acres of vegetated barrier habitats would be restored/created that would contribute to improving water quality as well as contribute to developing a more robust Terrebonne Basin barrier island system, provide a more robust marine-estuarine geomorphic boundary, and contribute to restricting higher salinity Gulf of Mexico waters from entering fresher interior estuarine areas thereby helping stabilize salinity regimes in the lower portions of the Terrebonne Basin.

5.3.1.6.3 Cumulative

Compared to the No Action Alternative, the incremental cumulative impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) but to a lesser degree. These impacts would contribute to improving water quality within lower portions of the Terrebonne Basin, work synergistically with other restoration efforts contributing to the stabilization of the marine – estuarine system and salinity regimes within the lower Terrebonne Basin. The incremental impacts of implementing Alternative 4 would be in synergistic combination to water quality impacts and benefits for overall net acres of barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.3.2 Salinity

5.3.2.1 No action Alternative (Future without Project Conditions)

5.3.2.1.1 Direct

Barrier islands are critical in maintaining salinity gradients between the marine and estuarine system, which in turn is vital for proper functioning of the associated estuarine systems (Knotts, et al. 2006). The Terrebonne Basin barrier islands define the Terrebonne Basin marine – estuarine boundary, restrict water exchange between the marine and estuarine systems, and provide storm surge protection to wetlands and human infrastructure, and modify currents and salinity within the bay systems (Britton and Morton 1989; Day et al. 1989).

The No Action Alternative, not implementing the Terrebonne Basin barrier shoreline restoration, would have no direct impacts on salinity. Existing conditions would continue with degradation and eventual loss of the Terrebonne Basin barrier system thereby resulting in higher salinity waters from the Gulf of Mexico to intrusion into the lower estuarine interior wetlands and disrupting the existing estuarine salinity gradient.

5.3.2.1.2 Indirect

Without any action, the seven island 3,220-acre Terrebonne Basin barrier system (East Timbalier, Timbalier, Trinity, East Island, Wine, Whiskey and Raccoon Island) would continue to degrade, fragment and eventually convert into shallow open water bottoms. The Terrebonne Basin barrier island system would continue to experience higher wave energy levels and associated shoreline erosion in the adjacent bays (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005). Loss of the geomorphic barrier system boundary would change the tidal prism dynamics resulting in increased interior land loss and conversion of the Terrebonne Basin estuarine system to a more marine system thereby significantly reducing productivity (Penland et al., 2003). Vegetation species would be dominated by more salt tolerant species and existing salt-intolerant species would be displaced to fresher inland areas.

If the Terrebonne Basin barrier island system is not restored, the adjacent estuarine bay systems, along with their various significant resources, would continue to be transformed into marine open water habitats. The loss of the Terrebonne Basin barrier system would result in the loss of important transitional habitat between estuarine and marine environments; essential fish habitat (EFH);

unique wildlife habitat (e.g., nursery, nesting, feeding, and roosting habitats); and critical wintering habitat for the threatened piping plover. The continued degradation and eventual loss of the Terrebonne Basin barrier system would result in the loss of fish and wildlife habitat which would likely increase competition between and within various fish and wildlife species for diminishing habitat resources. The loss of vegetated wetlands would also result in a loss in primary productivity and eventually result in conversion of the existing back bay estuarine system into more marine open water system devoid of vegetation resources.

5.3.2.1.3 Cumulative

Louisiana has lost approximately 1,900 square miles (492,097 ha) of coastal wetlands, including barrier resources, since the 1930's (Dunbar et al. 1992; Barras et al. 1994; Barras et al. 2003). Approximately 10 percent of Louisiana's remaining coastal wetlands, including barrier islands, would be lost at a rate of approximately 6,600 acres per year (2,672 ha per year) over the next 50 years, resulting in an additional net loss of 328,000 acres (132,794 ha) by 2050 (Barras et al. 2003).

Approximately 3,220 acres, almost the entire Terrebonne barrier islands system, projected to be lost by 2062. The projected loss of the Terrebonne barrier islands, in synergistic combination with the loss of other barrier island losses, would alter the salinity regimes within the back bay estuarine systems converting them to more marine-open water systems and resulting in the concomitant loss of various plant and animals that utilize not only transitional barrier island habitats but also the estuarine habitats.

The LCA Study (USACE, 2004) estimated coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year over the next 50 years. The projected loss of the Terrebonne Basin barrier island system and the conversion and loss of estuarine habitats would be in addition to the projected loss of similar resources throughout coastal Louisiana. These impacts would be offset, to some degree by other Federal, State, and local coastal barrier restoration efforts.

5.3.2.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.3.2.2.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 5 (NER Plan) on salinity would be negligible, if at all.

5.3.2.2.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 5 (NER Plan) would restore a net total of 2,781 acres on Raccoon, Whiskey, Trinity and Timbalier Islands restoring these barrier islands to their minimal geormorphological form and ecological functions. Implementing

Alternative 5 (NER Plan) would maintain the important geomorphic boundary between the higher salinity waters from the Gulf of Mexico and the less saline Terrebonne estuarine system thereby preventing the conversion of the barrier system and the interior estuarine systems to open marine habitats and contribute to maintaining the estuarine salinity gradients. Restoration of these four islands would also, consistent with Stone (2005), absorb wave energy during storms and fair-weather conditions, thereby providing some storm surge protection for the interior estuarine marshes within the basin, which would decrease land loss erosion rates to some unknown extent.

Implementing Alternative 5 (NER Plan) would restore a portion of the natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur) thereby reducing, to some unknown extent, the annual economic loss to Louisiana and the nation (after Van Heerden and DeRouen 1997). Furthermore, the proposed barrier shoreline restoration would contribute to the "Cajun" culture and its people thereby indirectly impacting the State's economy and advancing by some unknown extent, the economic development of the State of Louisiana.

5.3.2.2.3 Cumulative

Cumulative impacts to salinity would be the synergistic effects of implementing Alternative 5 (NER Plan), restoring a net total of 2,781 acres on four of the Terrebonne Basin barrier islands thereby maintaining the geomorphic boundary between the higher salinity waters from the Gulf of Mexico and the less saline Terrebonne estuarine system. This action, in synergistic combination with other Federal, State and local barrier island restoration actions, would prevent the conversion of the barrier systems and the interior estuarine systems to open marine habitats and contribute to maintaining estuarine salinity gradients. Restoring Louisiana's coastal barrier islands have been addressed, to some degree, by efforts under the CWPPRA program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 *et. seq*.

5.3.2.3 Alternative 11: Whiskey (Plan C)

5.3.2.3.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 11 on salinity would be negligible, if at all.

5.3.2.3.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including restoring a net total of 527 acres of Whiskey Island to its minimal geormorphological form and ecological functions over the 50-year period of analysis thereby preventing the conversion of a portion of the Terrebonne barrier system and the interior estuarine systems to open marine habitats as well as contributing to maintaining the estuarine salinity gradients.

5.3.2.3.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 11 restoring a net total of 527 acres on Whiskey Island to its minimal geormorphological form and ecological functions with the additive combination of impacts and benefits for overall net acres of barrier islands created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts. Coastal barrier land loss in Louisiana has been addressed, to some degree, by efforts under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 *et. seq*.

5.3.2.4 Alternative 2: Timbalier (Plan E)

5.3.2.4.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 2 on salinity would be negligible, if at all.

5.3.2.4.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan), including restoring a net total of 1,324 acres of Timbalier Island to its minimal geormorphological form and ecological functions over the 50-year period of analysis thereby preventing the conversion of a portion of the Terrebonne barrier system and the interior estuarine systems to open marine habitats as well as contributing to maintaining the estuarine salinity gradients.

5.3.2.4.3 Cumulative

Cumulative impacts would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 2 (first component of construction) restoring a net total of 1,324 acres on Timbalier Island to its minimal geormorphological form and ecological functions with the additive combination of impacts and benefits for overall net acres of barrier islands created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts. Coastal barrier land loss in Louisiana has been addressed, to some degree, by efforts under the Coastal

Wetlands Planning, Protection and Restoration Act (CWPPRA) program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 *et. seq*.

5.3.2.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.3.2.5.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 3 on salinity would be negligible, if at all.

5.3.2.5.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan), including restoring a net total of 1,851 acres of Whiskey and Timbalier Islands to their minimal geormorphological forms and ecological functions over the 50-year period of analysis thereby preventing the conversion of a portion of the Terrebonne barrier system and the interior estuarine systems to open marine habitats as well as contributing to maintaining the estuarine salinity gradients.

5.3.2.5.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 3 restoring a net total of 1,851 acres on Whiskey and Timbalier Islands to their minimal geormorphological forms and ecological functions with the additive combination of impacts and benefits for overall net acres of barrier islands created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts. Coastal barrier land loss in Louisiana has been addressed, to some degree, by efforts under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 *et. seq*.

5.3.2.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.3.2.6.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 4 on salinity would be negligible, if at all.

5.3.2.6.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 4 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan), including restoring a net total of 2,140 acres of Whiskey, Trinity and Timbalier Islands to their minimal geormorphological forms and ecological functions over the 50-year period of analysis thereby preventing the conversion of a portion of the Terrebonne barrier system and the interior estuarine systems to open marine habitats as well as contributing to maintaining the estuarine salinity gradients.

5.3.2.6.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 3 restoring a net total of 2,140 acres on Whiskey, Trinity and Timbalier Islands to their minimal geormorphological forms and ecological functions with the additive combination of impacts and benefits for overall net acres of barrier islands created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts. Coastal barrier land loss in Louisiana has been addressed, to some degree, by efforts under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 *et. seq*.

5.4 AIR QUALITY

5.4.1.1 No action Alternative (Future without Project Conditions)

5.4.1.1.1 Direct

The No Action Alternative, not implementing Terrebonne Basin barrier island restoration, would have no direct impacts on air quality. Existing conditions would persist. The institutional recognition of air quality would likely continue with additional regulations.

5.4.1.1.2 Indirect

Without any action, air quality throughout the coastal Louisiana area, including the Study Area, would likely continue to decline into the future. The EPA (2009) recently assessed the impacts of global change on regional US air quality. This report points out the challenges of understanding global to regional climate and air quality modeling because of the large number of physical, chemical, and biological processes involved, many of which are poorly understood, all interacting in complex ways. Reasons for the predicted air quality decline include: continued human population growth throughout the general coastal area, further commercialization and industrialization (e.g., oil and gas operations), increased numbers of motor vehicles, and increased emissions from various engines.

These indirect impacts would be coupled with the continued loss of coastal wetland vegetation that would no longer be available to remove gaseous pollutants. There would likely be associated increases in respiratory aliments (such as asthma) in the human populations. Air pollution would also have adverse aesthetic impacts on coastal viewscapes. These impacts would probably also have some impacts on the respiratory health of humans and potentially terrestrial wildlife, but information on such impacts is not readily available.

5.4.1.1.3 Cumulative

Continued institutional recognition of air quality, along with the continued deterioration of air quality throughout the nation and region would likely continue to occur. Approximately 10 percent of Louisiana's remaining coastal wetlands, including barrier islands, would be lost at a rate of approximately 6,600 acres per year over the next 50 years, resulting in an additional net loss of 328,000 acres by 2050 (Barras et al. 2003). Approximately 3,220 acres, almost the entire Terrebonne barrier islands system, is projected to be lost by 2062. The projected losses of the Terrebonne barrier islands, in synergistic combination with the loss of other barrier island losses, would contribute, to some unknown extent (EPA 2009), to altering air quality. However, these impacts to air quality would be offset, to some degree by other Federal, State and local wetland and barrier restoration projects.

5.4.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.4.1.2.1 Direct

Compared to the No Action Alternative, Direct impacts to ambient air quality, resulting primarily from implementing Alternative 5 (NER Plan) would be primarily related to emissions of construction equipment within the Study Area. Impacts would be temporary and localized, with air quality returning to pre-construction conditions shortly after completion of construction activities. The Study Area is located within Terrebonne Parish which is presently in attainment for air quality. An air applicability determination analysis was performed based upon direct and indirect emissions for estimated construction hours. Generally, since no other indirect Federal action, such as licensing or subsequent actions would be required or related to the restoration construction actions, any indirect emissions, if they would occur, would be negligible. Consideration of total emissions for each work item separately would not exceed the threshold limit applicable to volatile organic compounds (VOCs) or nitrous oxid (NOx). Such emissions would be classified as de minimus and no further action would be required.

5.4.1.2.2 Indirect

Over the 50-year period of analysis Alternative 5 (NER Plan) would restore a net total of 1,459 acres of vegetated barrier habitats that would help to improve local air quality by reducing particulates and gaseous air pollutants. It is reasonable to extrapolate from the findings of researchers such as David J. Nowak (personal communication, David J. Nowak, Project Leader, USDA Forest Service, Northeastern Research Station, 5 Moon Library, SUNY-CESF, Syracuse, New York) that the trees and vegetation in coastal Louisiana would improve air quality. Improvement of air quality would provide positive benefits for humans overall, although this relative difference would likely be minimal because of the size of the Study Area and distance from human population centers.

Implementing Alternative 5 (NER Plan) would restore a portion of the natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur) thereby reducing, to some unknown extent, the annual economic loss to Louisiana and the nation (after Van Heerden and DeRouen 1997). Furthermore, the proposed barrier shoreline restoration would contribute to the "Cajun" culture and its people thereby indirectly impacting the State's economy and advancing by some unknown extent, the economic development of the State of Louisiana.

5.4.1.2.3 Cumulative

Cumulative impacts to air quality bottoms would be the synergistic effect of implementing Alternative 5 (NER Plan), with restoration of a net total of 1,459 acres of vegetated barrier habitats, along with the synergistic combination of impacts and benefits for overall net acres of vegetated barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts. Coastal barrier island restoration in Louisiana has been addressed, to some degree, by efforts under the CWPPRA program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq.impacts and benefits of existing wetlands being converted.

5.4.1.3 Alternative 11: Whiskey (Plan C)

5.4.1.3.1 Direct

Compared to the No Action Alternative, direct impacts to ambient air quality of implementing alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), although to a much lesser extent.

5.4.1.3.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER) with restoration of a net total of 311 acres of vegetated barrier habitats that would help to improve local air quality by reducing particulates and gaseous air pollutants.

5.4.1.3.3 Cumulative

Cumulative impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) with restoration of a net total of 311 acres of vegetated barrier habitats, along with the synergistic combination of impacts and benefits for overall net acres of vegetated barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.4.1.4 Alternative 2: Timbalier (Plan E)

5.4.1.4.1 Direct

Compared to the No Action Alternative, direct impacts to ambient air quality of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan), although to a much lesser extent.

5.4.1.4.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 2 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) with restoration of a net total of 706 acres of vegetated barrier habitats that would help to improve local air quality by reducing particulates and gaseous air pollutants.

5.4.1.4.3 Cumulative

Cumulative impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) with restoration of a net total of 706 acres of vegetated barrier habitats, along with the synergistic combination of impacts and benefits for overall net acres of vegetated barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts).

5.4.1.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.4.1.5.1 Direct

Compared to the No Action Alternative, direct impacts to ambient air quality of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan), although to a much lesser extent.

5.4.1.5.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) with restoration of a net total of 1,017 acres of vegetated barrier habitats that would help to improve local air quality by reducing particulates and gaseous air pollutants.

5.4.1.5.3 Cumulative

Cumulative impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) with restoration of a net total of 1,017 acres of vegetated barrier habitats, along with the synergistic combination of impacts and benefits for overall net acres of vegetated barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.4.1.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.4.1.6.1 Direct

Compared to the No Action Alternative, direct impacts to ambient air quality of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan), although to a much lesser extent.

5.4.1.6.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) with restoration of a net total of 1,120 acres of vegetated barrier habitats that would help to improve local air quality by reducing particulates and gaseous air pollutants.

5.4.1.6.3 Cumulative

Cumulative impacts of implementing Alternative 3 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) with restoration of a net total of 1,120 acres of vegetated barrier habitats, along with the synergistic combination of impacts and benefits for overall net acres of vegetated barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

5.5 NOISE

5.5.1.1 No Action Alternative (Future without Project Conditions

5.5.1.1.1 Direct

The No Action Alternative, not implementing the barrier island restoration features, would have no direct impact on noise. Existing conditions would persist. Institutional recognition of noise, such as provided by the regulations for Occupational Noise Exposure (29 CFR Part 1910.95) under the Occupational Safety and Health Act of 1970, as amended, would continue. Localized and temporary noise impacts, such as commercial and recreational fishing boats and oil and gas exploration activities, would likely continue to affect fish, wildlife and those humans that utilize the Study Area.

5.5.1.1.2 Indirect

There would be no indirect impacts of the No-Action Alternative on noise. Not implementing the barrier island restoration features would result in the persistence of existing conditions. The Study Area consists of remote and uninhabited barrier islands.

5.5.1.1.3 Cumulative

There would be no cumulative impacts of the No-Action Alternative on noise. Not implementing the barrier island restoration features would result in the persistence of existing conditions. The Study Area consists of remote and uninhabited barrier islands. The noise from nearby urban areas has little, if any, impact on the Study Area. This is expected to continue in the future.

5.5.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.5.1.2.1 Direct

Compared to the No Action Alternative, construction activities associated with implementing Alternative 5 (NER Plan) would result in temporary and localized increases to noise levels in the Study Area. Potential noise impacts concerns would be expected from construction activities, although construction equipment is limited in the level of noise that can be emitted. Institutional recognition of noise, such as provided by the regulations for Occupational Noise Exposure (29 CFR Part 1910.95) under the Occupational Safety and Health Act of 1970, as amended, would continue. The Occupational Noise Exposure regulation mandate that noise levels emitted from construction equipment be below 90 dB for exposures of eight hours per day or more.

During the 2,480 day long construction period (mobilization/demobilization not included), localized and temporary noise impacts would likely result in wildlife and fishery resources temporarily displaced from the Study Area during construction activities. In some instances, noise impacts may directly impact fish and wildlife species. These organisms would generally avoid the construction area. However, tolerance of unnatural disturbance varies among wildlife. Therefore coordination with the USFWS in identifying the key species of concern and following feasible administrative and or engineering controls, determining and implementing appropriate buffer zones, and implementing construction activity windows, would be implemented to address these issues.

5.5.1.2.2 Indirect

Compared to the No Action Alternative, there are no anticipated long-term significant adverse indirect noise impacts of implementing Alternative 5 (NER Plan). Any project-related noise impacts are expected to be localized, temporary, and minor in nature.

5.5.1.2.3 Cumulative

Compared to the No Action Alternative, cumulative noise impacts of implementing Alternative 5 (NER Plan) would be localized and short-term causing local fish and wildlife populations to relocate during construction. Long-term adverse cumulative impacts due to noise levels would not be expected with implementation of Alternative 5 (NER Plan) when considered in combination with impacts and benefits of other Federal, State, local, and private restoration efforts.

5.5.1.3 Alternative 11: Whiskey (Plan C)

5.5.1.3.1 Direct

Compared to the No Action Alternative, direct impacts to noise associated with implementing Alternative 11 would be similar to the Whiskey Island component of Alternative 5 (NER Plan)) resulting in temporary and localized increases to noise levels in the Study Area during construction. Once construction activities are completed, noise levels would return to pre-construction conditions.

5.5.1.3.2 Indirect

Compared to the No Action Alternative, indirect impacts to noise of implementing Alternative 11 would be similar to the Whiskey Island component of Alternative 5 (NER Plan). There are no anticipated long-term significant adverse indirect noise impacts of implementing Alternative 11 (first component of construction). Any project-related noise impacts are expected to be localized, temporary, and minor in nature.

5.5.1.3.3 Cumulative

Compared to the No Action Alternative, incremental cumulative impacts to noise from implementing Alternative 11 would be similar to the Whiskey Island component of Alternative 5 (NER Plan). There are no anticipated long-term significant adverse cumulative noise impacts of implementing Alternative 11. Long-term adverse cumulative impacts due to noise would not be expected with implementation of Alternative 11 when considered in combination with impacts and benefits of other Federal, State, local, and private restoration efforts.

5.5.1.4 Alternative 2: Timbalier (Plan E)

5.5.1.4.1 Direct

Compared to the No Action Alternative, direct impacts to noise associated with implementing Alternative 2 (first component of construction) would be similar to the Timbalier Island component of Alternative 5 (NER Plan) resulting in temporary and localized increases to noise levels in the Study Area during construction. Once construction activities are completed, noise levels would return to pre-construction conditions.

5.5.1.4.2 Indirect

Compared to the No Action Alternative, indirect impacts to noise of implementing Alternative 2 would be similar to the Timbalier Island component of Alternative 5 (NER Plan). There are no anticipated long-term significant adverse indirect noise impacts of implementing Alternative 2. Any project-related noise impacts are expected to be localized, temporary, and minor in nature.

5.5.1.4.3 Cumulative

Compared to the No Action Alternative, incremental cumulative impacts to noise from implementing Alternative 2 would be similar to the Timbalier Island component of Alternative 5 (NER Plan). There are no anticipated long-term significant adverse cumulative noise impacts of implementing Alternative 2. Long-term adverse cumulative impacts due to noise would not be expected with implementation of Alternative 2 when considered in combination with impacts and benefits of other Federal, State, local, and private restoration efforts.

5.5.1.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.5.1.5.1 Direct

Compared to the No Action Alternative, direct impacts to noise associated with implementing Alternative 3 (first component of construction) would be similar to the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) resulting in temporary and localized increases to noise levels in the Study Area during construction. Once construction activities are completed, noise levels would return to pre-construction conditions.

5.5.1.5.2 Indirect

Compared to the No Action Alternative, indirect impacts to noise of implementing Alternative 3 would be similar to the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan). There are no anticipated long-term significant adverse indirect noise impacts of implementing Alternative 3. Any project-related noise impacts are expected to be localized, temporary, and minor in nature.

5.5.1.5.3 Cumulative

Compared to the No Action Alternative, incremental cumulative impacts to noise from implementing Alternative 3 would be similar to the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan). There are no anticipated long-term significant adverse cumulative noise impacts of implementing Alternative 3.

Long-term adverse cumulative impacts due to noise would not be expected with implementation of Alternative 3 when considered in combination with impacts and benefits of other Federal, State, local, and private restoration efforts.

5.5.1.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.5.1.6.1 Direct

Compared to the No Action Alternative, direct impacts to noise associated with implementing Alternative 4 (first component of construction) would be similar to the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) resulting in temporary and localized increases to noise levels in the Study Area during construction. Once construction activities are completed, noise levels would return to pre-construction conditions.

5.5.1.6.2 Indirect

Compared to the No Action Alternative, indirect impacts to noise of implementing Alternative 4 would be similar to the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan). There are no anticipated long-term significant adverse indirect noise impacts of implementing Alternative 4. Any project-related noise impacts are expected to be localized, temporary, and minor in nature.

5.5.1.6.3 Cumulative

Compared to the No Action Alternative, incremental cumulative impacts to noise from implementing Alternative 4 would be similar to the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan). There are no anticipated long-term significant adverse cumulative noise impacts of implementing Alternative 4. Long-term adverse cumulative impacts due to noise would not be expected with implementation of Alternative 4 when considered in combination with impacts and benefits of other Federal, State, local, and private restoration efforts.

5.6 VEGETATION RESOURCES

5.6.1 Riparian Vegetation Resources

5.6.1.1 No Action Alternative (Future without Project Conditions)

5.6.1.1.1 Direct

The No Action Alternative, not implementing the Terrebonne Basin barrier islands restoration project, would have no direct impacts to riparian vegetation as no such resources are present on the barrier islands. However, existing conditions, including the continued loss of riparian vegetation resources within the adjacent Terrebonne Basin estuarine system would persist.

5.6.1.1.2 Indirect

There are no existing riparian vegetation resources on the Terrebonne Basin barrier islands. Hence, without any action there would be no indirect impacts on the Terrebonne Basin barrier islands to riparian vegetation resources.

Without any action, approximately 3,220 acres of existing barrier resources from the seven island Terrebonne Basin barrier system (East Timbalier, Timbalier, Trinity, East Island, Wine, Whiskey and Raccoon Island) would likely continue to degrade, fragment and eventually convert into shallow open water bottoms over the 50-year period of analysis. The loss of the Terrebonne Basin barrier island system would consequently result in higher wave energy levels and associated shoreline erosion in the adjacent estuarine bays (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005). Some unknown portions of the adjacent estuarine systems, along with their riparian vegetation resources, would be transformed into open water habitat.

The loss of estuarine riparian vegetation resources would result in adverse impacts to important transitional habitat between estuarine and terrestrial environments as well as unique wildlife habitat (e.g., nursery, nesting, feeding, and roosting habitats). The degradation and eventual loss of estuarine riparian vegetation resources would also result in the loss of important wildlife habitat which would likely increase competition between and within various wildlife species for diminishing habitat resources. The loss of estuarine riparian vegetated habitat would also result in a loss in primary productivity, as well as undetermined impacts to recreation, aesthetic and associated socioeconomic resources.

5.6.1.1.3 Cumulative

The incremental cumulative impacts of the No Action Alternative would be the conversion of some unknown acreage of estuarine riparian vegetation resources due to the higher wave energy levels and associated shoreline erosion (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005) resulting from the loss of the Terrebonne Basin barrier island system and other coastal Louisiana barrier systems.

These impacts would be offset, to some degree, by the synergistic additive combination of impacts and benefits of coastal barrier island restoration by other Federal, State, local, and private restoration efforts that would protect adjacent estuarine systems, and their associated riparian vegetation resources, from converting to shallow open water habitats. Coastal barrier islands in Louisiana have been restored, to some degree, by efforts under the CWPPRA program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq.

5.6.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.6.1.2.1 Direct

There would be no direct impacts to riparian wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 5 (NER Plan) would be similar to the No Action Alternative.

5.6.1.2.2 Indirect

There would be no indirect impacts of implementing Alternative 5 (NER Plan) on the Terrebonne Basin barrier islands as there are no riparian vegetation resources on the barrier islands.

However, compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would restore a net total of 2,781 acres on Raccoon, Timbalier, Trinity, and Whiskey Islands. Restoring these barrier islands to their minimal geormorphological form would result, consistent with Stone and McBride (1998), Stone et al. (2003) and Stone et al. (2005), in the restored barrier islands absorbing wave energy during storms and fair-weather conditions and providing some storm surge protection. Restoring the Terrebonne Basin barrier islands to their geomorphologic form would also contribute to their ecological function of preventing conversion of the estuarine system, especially riparian vegetation resources, to open water habitat.

Implementing Alternative 5 (NER Plan) would restoring four of the seven Terrebonne barrier islands to their minimal geormorphological form thereby reducing, to some undetermined level, the loss of adjacent estuarine riparian vegetation resources. This action would prevent/reduce the conversion of some unknown portion of the existing back bay estuarine system and its riparian vegetation resources into more open water system.

The estuarine riparian vegetation resources would, in turn, provide important transitional habitat between estuarine and terrestrial environments as well as unique wildlife habitat (e.g., nursery, nesting, feeding, and roosting habitats). In addition, preventing/reducing the loss of estuarine riparian vegetation resources would provide important wildlife habitat which would likely decrease competition between and within various wildlife species for diminishing habitat resources. The prevention/reduction of loss of riparian vegetated habitat would also result in an undetermined increase in primary productivity compared to the No Action Alternative.

Implementing Alternative 5 (NER Plan) would restore a portion of the natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur) thereby reducing, to some unknown extent, the annual economic loss to Louisiana and the nation (after Van Heerden and DeRouen 1997). Furthermore, the proposed barrier shoreline restoration would contribute to the "Cajun" culture and its people thereby indirectly impacting the State's economy and advancing by some unknown extent, the economic development of the State of Louisiana.

5.6.1.2.3 Cumulative

Cumulative impacts would be the incremental impacts to riparian vegetation resources from implementing Alternative 5 (NER Plan) when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 5 (NER Plan) would restore the geomorphologic form and ecological function to a net total of 2,781 acres of Terrebonne barrier island resources. Restoration of the geomorphologic form to Raccoon, Whiskey, Trinity and Timbalier Islands would, consistent with Stone (2005), enable these barrier islands to maintain their ecological function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated riparian vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.1.3 Alternative 11: Whiskey (Plan C)

5.6.1.3.1 Direct

There would be no direct impacts to riparian wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 11 would be similar to the No Action Alternative.

5.6.1.3.2 Indirect

There would be no indirect impacts of implementing Alternative 11 on the Terrebonne Basin barrier islands as there are no riparian vegetation resources on the Terrebonne Basin barrier islands.

Compared to the No Action Alternative, indirect impacts to riparian vegetation resources of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER) but to a lesser degree. Alternative 11 would restore a net total of 527 acres thereby restoring Whiskey Island to its geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially riparian vegetation resources, to open water habitat.

5.6.1.3.3 Cumulative

These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

Cumulative impacts would be the incremental impacts to riparian vegetation resources from implementing Alternative 11 when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 11 would restore the geomorphologic form and ecological function to a net total of 527 acres on Whiskey Island. Restoration of the geomorphologic form to Whiskey Island would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated riparian vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.1.4 Alternative 2: Timbalier (Plan E)

5.6.1.4.1 Direct

There would be no direct impacts to riparian wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 2 would be similar to the No Action Alternative.

5.6.1.4.2 Indirect

There would be no indirect impacts of implementing Alternative 2 on the Terrebonne Basin barrier islands as there are no riparian vegetation resources on the Terrebonne Basin barrier islands.

Compared to the No Action Alternative, indirect impacts to riparian vegetation resources of implementing Alternative 2 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) but to a lesser degree. Alternative 2 would restore a net total of 1,324 acres thereby restoring Timbalier Island to its geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially riparian vegetation resources, to open water habitat.

5.6.1.4.3 Cumulative

Cumulative impacts would be the incremental impacts to riparian vegetation resources from implementing Alternative 2 when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 2 would restore the geomorphologic form and ecological function to a net total of 1,324 acres on Timbalier Island. Restoration of the geomorphologic form to Timbalier Island would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated riparian vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.1.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.6.1.5.1 Direct

There would be no direct impacts to riparian wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 3 would be similar to the No Action Alternative.

5.6.1.5.2 Indirect

There would be no indirect impacts of implementing Alternative 3 on the Terrebonne Basin barrier islands as there are no riparian vegetation resources on the Terrebonne Basin barrier islands.

Compared to the No Action Alternative, indirect impacts to riparian vegetation resources of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) but to a lesser degree. Alternative 3 would restore a net total of 1,851 acres thereby restoring Whiskey and Timbalier Islands to their geomorphologic forms which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially riparian vegetation resources, to open water habitat.

5.6.1.5.3 Cumulative

Cumulative impacts would be the incremental impacts to riparian vegetation resources from implementing Alternative 3 when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 3 would restore the geomorphologic form and ecological function to a net total of 1,851 acres on Whiskey and Timbalier Islands. Restoration of the geomorphologic form to Whiskey and Timbalier Islands would, consistent with Stone (2005), enable these barrier islands to maintain their function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated riparian vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the

Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.1.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.6.1.6.1 Direct

There would be no direct impacts to riparian wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 4 would be similar to the No Action Alternative.

5.6.1.6.2 Indirect

There would be no indirect impacts of implementing Alternative 4 on the Terrebonne Basin barrier islands as there are no riparian vegetation resources on the Terrebonne Basin barrier islands.

Compared to the No Action Alternative, indirect impacts to riparian vegetation resources of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 4 but to a lesser degree. Alternative 4 would restore a net total of 2,140 acres thereby restoring Whiskey, Trinity and Timbalier Islands to their geomorphologic forms which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially riparian vegetation resources, to open water habitat.

5.6.1.6.3 Cumulative

Cumulative impacts would be the incremental impacts to riparian vegetation resources from implementing Alternative 4 when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 4 would restore the geomorphologic form and ecological function to a net total of 2,140 acres on Whiskey, Trinity and Timbalier Islands. Restoration of the geomorphologic form to Whiskey, Trinity and Timbalier Islands would, consistent with Stone (2005), enable these barrier islands to maintain their function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated riparian vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.2 Wetland Vegetation Resources

5.6.2.1 No Action Alternative (Future without Project Conditions)

5.6.2.1.1 Direct

The No Action Alternative, not implementing the Terrebonne Basin barrier islands restoration project, would have no direct impacts on existing barrier island wetland vegetation resources or on adjacent Terrebonne Basin estuarine wetland vegetation resources. Existing conditions, the continued loss of barrier island wetland vegetation (beach, dune and marsh) and Terrebonne Basin estuarine wetland vegetation resources, would persist.

5.6.2.1.2 Indirect

Without any action, wetland vegetation resources from the seven island Terrebonne Basin barrier system and the adjacent Terrebonne Basin estuarine system would likely continue to degrade, fragment and eventually convert into shallow open water bottom habitat over the 50-year period of analysis.

The No Action Alternative would result in the conversion of 3,220 acres of existing Terrebonne Basin barrier island beach, dune and marsh wetland vegetation habitats to open water bottom habitat over the 50-year period of analysis. The loss of the Terrebonne Basin barrier island system would consequently result in higher wave energy levels and associated shoreline erosion in the adjacent estuarine bays (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005). Some unknown portions of the adjacent estuarine systems, along with their wetland vegetation resources, would be transformed into open water habitat.

The trend in barrier island loss is characterized by simultaneous reduction of total area and elevation resulting in a reduction in the size and diversity of vegetation zones, to varying degrees, across all of the barrier islands. Continued degradation and loss, combined with loss of replenishing processes, has also accelerated decline in the interdependent processes of plant production and vertical maintenance necessary for a stable barrier island ecosystem.

Conversion of existing barrier and estuarine wetland vegetation habitats would include degradation and loss of important and essential fish and wildlife habitats used for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements; reduction in productivity; degradation and loss of EFH, especially transitional habitat between estuarine and marine environments; degradation and loss of stopover habitat for migrating neotropic birds; and increased inter- and intra-specific competition between resident and migratory fish and wildlife species for decreasing coastal barrier island resources, as well as undetermined impacts to recreation, aesthetic and associated socioeconomic resources.

5.6.2.1.3 Cumulative

The incremental cumulative impacts of the No Action Alternative would be the conversion of some unknown acreage of Terrebonne Basin barrier island wetland vegetation resources to open water bottom habitats. In addition, there would be undetermined impacts to adjacent Terrebonne Basin estuarine wetland vegetation resources due to the higher wave energy levels and associated shoreline erosion (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005) resulting from Terrebonne Basin barrier island conversion to open water bottom habitat.

These impacts would be offset, to some degree, by the synergistic additive combination of impacts and benefits of coastal barrier island restoration by other Federal, State, local, and private restoration efforts that would restore barrier island wetland vegetation resources that would, in turn, protect adjacent estuarine systems and their associated wetland vegetation resources from converting to shallow open water habitats. Coastal barrier islands in Louisiana have been restored, to some degree, by efforts under the CWPPRA program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq.

5.6.2.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.6.2.2.1 Direct

Compared to the No Action Alternative, direct impacts to wetland vegetation resources of implementing Alternative 5 (NER Plan) would primarily result from construction activities related to placement of borrow material on existing fragmented dune, supratidal, intertidal (gulfside and bayside) and shallow open water habitats. The proposed action would initially restore a total of 5,840 acres on Raccoon, Whiskey, Trinity, and Timbalier Islands. This would include initial restoration of a total of 472 acres of dune, 4,320 acres of supratidal and 1,048 acres of intertidal vegetated habitats.

Dune restoration for all alternatives would include installation of sand fencing and plantings of native vegetation that would be anticipated to promote additional dune elevation by capturing Aeolian sands. One shore parallel fence would likely be installed about 50 ft north of the southern toe of the dune to continue the capture of transported sand until the surface is vegetated. The sand fence would extend along the total length of the constructed dune. Sand fences must be installed in sequence/phases. The installation should start from the southern side of the dune so as to build dune towards the Gulf of Mexico and proceed north. Additional rows of sand fencing could be added once the existing sand fence is full (i.e. sand is stacked up to the top of the fence.)

Seeding of the dune platform (aerial or ground application) would be considered depending on the time of the year construction is completed. Rye grass seed could be considered if construction is completed in the summer or fall to be used as a ground cover during the winter months. Bermuda grass seed has been dispersed on the barrier island dune platforms in the past as well, but with strong objection by the Federal and State wildlife agencies as it is non-native.

Dune and supratidal plants would consist of a variety of dune species including bitter panicum (*Panicum amarum var amarum* 'Fourchon'), sea oats (*Uniola paniculata* 'Caminada'), marshhay cordgrass (*Spartina patens* 'Gulf Coast') and gulf cordgrass (*Spartina spartinae*). Plants shall be grown mainly in four inch containers (sea oats in a slightly larger container). Species recommendations may change due to soil properties and conditions, elevation after final construction, salinity, available soil moisture, and other site conditions.

Other plants that could be considered to add diversity (depending upon availability) include seacoast bluestem (*Schizachyrium maritimum*), seashore dropseed (*Sporobolous virginicus*), and salt grass (*Distichlis spicata*). Woody species that would be considered for planting (depending upon availability) on the dune and supratidal swale areas include, but are not limited to matrimony vine, wax myrtle, Iva frutescens, baccharis species, and hercules club. Plants on the dune, supratidal, and marsh platforms would likely be installed 5-ft apart with 20-ft between rows. However, woody vegetation would likely be planted at a density of 10-ft on center. On Trinity Island, construction impacts to much of the existing mangrove habitat would be avoided so that this would serve as both a seed and vegetative source.

Marsh plantings would primarily consist of smooth cordgrass (*Spartina alterniflora* 'Vermilion'). Depending upon availability, a smaller planting of black mangrove (*Avicennia germinans* 'Pelican') may be incorporated to add a larger seed bank for black mangroves. Plants shall mainly consist of vegetative plug material, four inch containers, or tube-tainers (mangroves). The marsh platform planting area would be filling broken marsh and shallow open water. Marsh plants would likely be placed approximately 20 ft apart with plants approximately 3-ft on center.

5.6.2.2.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing alternative 5 (NER Plan) would be a net increase of 2,781 acres with 2,883 average annual habitat units (AAHUs) of important and essential vegetated habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements; increased vegetation growth and productivity; and reduced inter- and intra-specific species competition between resident and non-resident fish and wildlife species for limited coastal vegetation. Alternative 5 (NER Plan) would restore and rehabilitate dune, supratidal and intertidal vegetated coastal barrier habitats; reduce conversion of these habitats to open water habitat; and provide higher quality EFH, especially nursery habitat, for several species, including brown and white shrimp, and blue crab. Vegetative plantings would contribute to re-establishment of a variety of wetland species that would further aid in sediment trapping. Vegetative productivity would likely increase due to increased vegetated acres of barrier habitats. Important stopover habitats used by migrating neotropical birds would be restored and sustained for future use over the 50-year period of analysis. Compared to the No Action Alternative, implementing

Alternative 5 (NER Plan) would delay the conversion of vegetated barrier habitats to open water habitats over the 50-year period of analysis.

In addition, compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would restore Raccoon, Timbalier, Trinity, and Whiskey Islands to their minimal geormorphological form would result, consistent with Stone and McBride (1998), Stone et al. (2003) and Stone et al. (2005), in the restored barrier islands absorbing wave energy during storms and fair-weather conditions and providing some storm surge protection. Restoring these four barrier islands to their geomorphologic form would also contribute to their ecological function of preventing conversion of the estuarine system, especially wetland vegetation resources, to open water habitat.

Implementing Alternative 5 (NER Plan) would restoring four of the seven Terrebonne barrier islands to their minimal geormorphological form thereby reducing, to some undetermined level, the loss of adjacent estuarine wetland vegetation resources. This action would prevent/reduce the conversion of some unknown portion of the existing Terrebonne Basin estuarine system and its wetland vegetation resources into more open water system.

The estuarine wetland vegetation resources would, in turn, provide important transitional habitat between estuarine and terrestrial environments as well as unique wildlife habitat (e.g., nursery, nesting, feeding, and roosting habitats). In addition, preventing/reducing the loss of estuarine riparian vegetation resources would provide important wildlife habitat which would likely decrease competition between and within various wildlife species for diminishing habitat resources. The prevention/reduction of loss of riparian vegetated habitat would also result in an undetermined increase in primary productivity compared to the No Action Alternative.

Implementing Alternative 5 (NER Plan) would restore a portion of the natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur) thereby reducing, to some unknown extent, the annual economic loss to Louisiana and the nation (after Van Heerden and DeRouen 1997). Furthermore, the proposed barrier shoreline restoration would contribute to the "Cajun" culture and its people thereby indirectly impacting the State's economy and advancing by some unknown extent, the economic development of the State of Louisiana.

5.6.2.2.3 Cumulative

Cumulative impacts would be the incremental impact from implementing Alternative 5 (NER Plan) when added to all past, present and reasonably foreseeable similar barrier restoration efforts. Alternative 5 (NER Plan) would restore a net total of 2,781 acres of fragmented dune, supratidal, intertidal (gulfside and bayside) and shallow open water habitats on Raccoon (net total 641 acres), Whiskey (net total 527 acres), Trinity (net total 289 acres), and Timbalier Islands (net total 1,324 acres) which would be in addition to impacts and benefits for overall net acres of vegetated barrier resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

In addition, Alternative 5 (NER Plan) would restore the geomorphologic form to Raccoon, Whiskey, Trinity and Timbalier Islands that would, consistent with Stone (2005), enable these barrier islands to maintain their ecological function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated riparian vegetation resources. Coastal barrier land loss in Louisiana has been addressed, to some degree, by efforts under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq.

5.6.2.3 Alternative 11: Whiskey (Plan C with renourishment)

5.6.2.3.1 Direct

Compared to the No Action Alternative, direct impact to wetland vegetation resources of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including initial restoration of a total 1,272 acres with 65 acres of dune, 830 acres of supratidal, 377 acres of intertidal vegetation resources on Whiskey Island.

5.6.2.3.2 Indirect

Compared to the No-Action Alternative, indirect impacts to wetland vegetation resources of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan). Alternative 11 (first component of construction) would restore a net total of 527 acres of wetland vegetation resources with 0 net acres dune, 164 net acres supratidal, and 363 net acres of intertidal vegetation resources over the 50-year period of analysis. In addition, Alternative 11 would restore Whiskey Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially wetland vegetation resources, to open water habitat.

5.6.2.3.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 11 restoring a net total of 527 acres of barrier wetland vegetation resources on Whiskey Island.

Alternative 11 would also, restore the minimal geomorphologic form to Whiskey Island that would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.2.4 Alternative 2: Timbalier (Plan E)

5.6.2.4.1 Direct

Compared to the No Action Alternative, direct impacts to wetland vegetation resources of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan), including initial restoration of a total 2,630 acres with 215 acres of dune, 2,346 acres of supratidal, 69 acres of intertidal vegetation resources on Timbalier Island.

5.6.2.4.2 Indirect

Compared to the No-Action Alternative, indirect impacts to wetland vegetation resources of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan). Alternative 2 would restore a net total of 1,324 acres of wetland vegetation resources with 0 net acres dune, 164 net acres supratidal, and 363 net acres of intertidal wetland vegetation resources over the 50-year period of analysis. In addition, Alternative 11 would restore Timbalier Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially wetland vegetation resources, to open water habitat.

5.6.2.4.3 Cumulative

Cumulative impacts would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 2 restoring a net total of 1,324 acres of barrier wetland vegetation resources on Timbalier Island.

Alternative 2 would also restore the minimal geomorphologic form to Timbalier Island that would, consistent with Stone (2005), enable this barrier island to maintain its ecological function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.2.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.6.2.5.1 Direct

Compared to the No Action Alternative, direct impacts to wetland vegetation resources of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands component of Alternative 5 (NER Plan), including initial restoration of a total 3,902 acres with 280 acres of dune, 3,176 acres of supratidal, 446 acres of intertidal vegetation resources on Whiskey and Timbalier Islands.

5.6.2.5.2 Indirect

Compared to the No-Action Alternative, indirect impacts to wetland vegetation resources of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan). Alternative 3 would restore a net total of 1,851 acres of wetland vegetation resources with 0 net acres dune, 400 net acres supratidal, and 1,451 net acres of intertidal wetland vegetation resources over the 50-year period of analysis. In addition, Alternative 3 would restore Whiskey and Timbalier Islands to their minimal geomorphologic form which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially wetland vegetation resources, to open water habitat.

5.6.2.5.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 3 restoring a net total of 1,851 acres of barrier wetland vegetation resources on Whiskey and Timbalier Islands.

Alternative 3 would also restore the minimal geomorphologic form to Whiskey and Timbalier Islands that would, consistent with Stone (2005), enable these barrier islands to maintain their ecological function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.2.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.6.2.6.1 Direct

Compared to the No Action Alternative, direct impacts to wetland vegetation resources of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands component of Alternative 5 (NER Plan), including initial restoration of a total 5,051 acres with 409 acres of dune, 3,632 acres of supratidal, 1,010 acres of intertidal vegetation resources on Whiskey, Trinity and Timbalier Islands.

5.6.2.6.2 Indirect

Compared to the No-Action Alternative, indirect impacts to wetland vegetation resources of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan). Alternative 4 would restore a net total of 2,140 acres of wetland vegetation resources with 0 net acres dune, 490 net acres supratidal, and 1,650 net acres of intertidal wetland vegetation resources over the 50-year period of analysis. In addition, Alternative 4 would restore Whiskey, Trinity and Timbalier Islands to their minimal geomorphologic form which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially wetland vegetation resources, to open water habitat.

5.6.2.6.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 4 restoring a net total of 2,140 acres of barrier wetland vegetation resources on Whiskey, Trinity and Timbalier Islands.

Alternative 4 would also restore the minimal geomorphologic form to Whiskey, Trinity and Timbalier Islands that would, consistent with Stone (2005), enable these barrier islands to maintain their ecological function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.3 Upland Vegetation Resources

5.6.3.1 No Action Alternative (Future without Project Conditions)

5.6.3.1.1 Direct

The No Action Alternative, not implementing the Terrebonne Basin barrier islands restoration project, would have no direct impacts to upland vegetation as no such resources are present on the barrier islands. However, existing conditions, including the continued loss of upland vegetation resources within the adjacent Terrebonne Basin estuarine system would persist.

5.6.3.1.2 Indirect

There are no existing upland vegetation resources on the Terrebonne Basin barrier islands. Hence, without any action there would be no indirect impacts on the Terrebonne Basin barrier islands to upland vegetation resources.

Without any action, approximately 3,220 acres of existing barrier resources from the seven island Terrebonne Basin barrier system (East Timbalier, Timbalier, Trinity, East Island, Wine, Whiskey and Raccoon Island) would likely continue to degrade, fragment and eventually convert into shallow open water bottoms over the 50-year period of analysis. The loss of the Terrebonne Basin barrier island system would consequently result in higher wave energy levels and associated shoreline erosion in the adjacent estuarine bays (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005). Some unknown portions of the adjacent estuarine systems, along with their upland vegetation resources, would be transformed into open water habitat.

The loss of estuarine upland vegetation resources would result in adverse impacts to wildlife habitat (e.g., used for nesting, feeding, and roosting habitats). The degradation and eventual loss of estuarine upland vegetation resources would also result in the loss of available wildlife habitats which would likely increase competition between and within various wildlife species for diminishing upland habitat resources. The loss of estuarine upland vegetated habitat would also result in a loss in primary productivity, as well as undetermined impacts to recreation, aesthetic and associated socioeconomic resources.

5.6.3.1.3 Cumulative

The incremental cumulative impacts of the No Action Alternative would be the conversion of some unknown acreage of estuarine upland vegetation resources due to the higher wave energy levels and associated shoreline erosion (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005) resulting from the loss of the Terrebonne Basin barrier island system and other coastal Louisiana barrier systems.

These impacts would be offset, to some degree, by the synergistic additive combination of impacts and benefits of coastal barrier island restoration by other Federal, State, local, and private restoration efforts that would protect adjacent estuarine systems, and their associated upland vegetation resources, from converting to shallow open water habitats. Coastal barrier islands in Louisiana have been restored, to some degree, by efforts under the CWPPRA program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq.

5.6.3.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.6.3.2.1 Direct

There would be no direct impacts to upland wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 5 (NER Plan) would be similar to the No Action Alternative.

5.6.3.2.2 Indirect

There would be no indirect impacts of implementing Alternative 5 (NER Plan) on the Terrebonne Basin barrier islands as there are no upland vegetation resources on the barrier islands.

However, compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would restore a net total of 2,781 acres on Raccoon, Timbalier, Trinity, and Whiskey Islands. Restoring these barrier islands to their minimal geormorphological form would result, consistent with Stone and McBride (1998), Stone et al. (2003) and Stone et al. (2005), in the restored barrier islands absorbing wave energy during storms and fair-weather conditions and providing some storm surge protection. Restoring the Terrebonne Basin barrier islands to their geomorphologic form would also contribute to their ecological function of preventing conversion of the estuarine system, especially upland vegetation resources, to open water habitat.

Implementing Alternative 5 (NER Plan) would restore four of the seven Terrebonne barrier islands to their minimal geormorphological form thereby reducing, to some undetermined level, the loss of adjacent estuarine upland vegetation resources. This action would prevent/reduce the conversion of some unknown portion of the existing back bay estuarine system and its upland vegetation resources into more open water system.

The estuarine upland vegetation resources would, in turn, provide important transitional habitat between estuarine and terrestrial environments as well as unique wildlife habitat (e.g., nesting, feeding, and roosting habitats). In addition, preventing/reducing the loss of estuarine upland vegetation resources would provide important wildlife habitat which would likely decrease competition between and within various wildlife species for diminishing habitat resources. The prevention/reduction of loss of upland vegetated habitat would also result in an undetermined increase in primary productivity compared to the No Action Alternative.

Implementing Alternative 5 (NER Plan) would restore a portion of the natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur) thereby reducing, to some unknown extent, the annual economic loss to Louisiana and the nation (after Van Heerden and DeRouen 1997). Furthermore, the proposed barrier shoreline restoration would contribute to the "Cajun" culture and its people thereby indirectly impacting the State's economy and advancing by some unknown extent, the economic development of the State of Louisiana.

5.6.3.2.3 Cumulative

Cumulative impacts would be the incremental impacts to upland vegetation resources from implementing Alternative 5 (NER Plan) when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 5 (NER Plan) would restore the geomorphologic form and ecological function to a net total of 2,781 acres of Terrebonne barrier island resources. Restoration of the geomorphologic form to Raccoon, Whiskey, Trinity and Timbalier Islands would, consistent with Stone (2005), enable these barrier islands to maintain their ecological function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated upland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.3.3 Alternative 11: Whiskey (Plan C)

5.6.3.3.1 Direct

There would be no direct impacts to upland wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 11 would be similar to the No Action Alternative.

5.6.3.3.2 Indirect

There would be no indirect impacts of implementing Alternative 11 on the Terrebonne Basin barrier islands as there are no upland vegetation resources on the Terrebonne Basin barrier islands.

Compared to the No Action Alternative, indirect impacts to upland vegetation resources of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER) but to a lesser degree. Alternative 11 would restore a net total of 527 acres thereby restoring Whiskey Island to its geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially upland vegetation resources, to open water habitat.

5.6.3.3.3 Cumulative

These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

Cumulative impacts would be the incremental impacts to upland vegetation resources from implementing Alternative 11 when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 11 would restore the geomorphologic form and ecological function to a net total of 527 acres on Whiskey Island. Restoration of the geomorphologic form to Whiskey Island would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated upland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.3.4 Alternative 2: Timbalier (Plan E)

5.6.3.4.1 Direct

There would be no direct impacts to upland wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 2 would be similar to the No Action Alternative.

5.6.3.4.2 Indirect

There would be no indirect impacts of implementing Alternative 2 on the Terrebonne Basin barrier islands as there are no upland vegetation resources on the Terrebonne Basin barrier islands.

Compared to the No Action Alternative, indirect impacts to upland vegetation resources of implementing Alternative 2 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) but to a lesser degree. Alternative 2 would restore a net total of 1,324 acres thereby restoring Timbalier Island to its geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially upland vegetation resources, to open water habitat.

5.6.3.4.3 Cumulative

Cumulative impacts would be the incremental impacts to upland vegetation resources from implementing Alternative 2 when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 2 would restore the geomorphologic form and ecological function to a net total of 1,324 acres on Timbalier Island. Restoration of the geomorphologic form to Timbalier Island would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated upland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.3.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.6.3.5.1 Direct

There would be no direct impacts to upland wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 3 would be similar to the No Action Alternative.

5.6.3.5.2 Indirect

There would be no indirect impacts of implementing Alternative 3 on the Terrebonne Basin barrier islands as there are no upland vegetation resources on the Terrebonne Basin barrier islands.

Compared to the No Action Alternative, indirect impacts to upland vegetation resources of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) but to a lesser degree. Alternative 3 would restore a net total of 1,851 acres thereby restoring Whiskey and Timbalier Islands to their geomorphologic forms which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially upland vegetation resources, to open water habitat.

5.6.3.5.3 Cumulative

Cumulative impacts would be the incremental impacts to upland vegetation resources from implementing Alternative 3 when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 3 would restore the geomorphologic form and ecological function to a net total of 1,851 acres on Whiskey and Timbalier Islands. Restoration of the geomorphologic form to Whiskey and Timbalier Islands would, consistent with Stone (2005), enable these barrier islands to maintain their function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated upland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.3.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.6.3.6.1 Direct

There would be no direct impacts to upland wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 4 would be similar to the No Action Alternative.

5.6.3.6.2 Indirect

There would be no indirect impacts of implementing Alternative 4 on the Terrebonne Basin barrier islands as there are no upland vegetation resources on the Terrebonne Basin barrier islands.

Compared to the No Action Alternative, indirect impacts to upland vegetation resources of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 4 but to a lesser degree. Alternative 4 would restore a net total of 2,140 acres thereby restoring Whiskey, Trinity and Timbalier Islands to their geomorphologic forms which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially upland vegetation resources, to open water habitat.

5.6.3.6.3 Cumulative

Cumulative impacts would be the incremental impacts to upland vegetation resources from implementing Alternative 4 when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 4 would restore the geomorphologic form and ecological function to a net total of 2,140 acres on Whiskey, Trinity and Timbalier Islands. Restoration of the geomorphologic form to Whiskey, Trinity and Timbalier Islands would, consistent with Stone (2005), enable these barrier islands to maintain their function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated upland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.4 Submerged Aquatic Vegetation (SAV)

5.6.4.1 No Action Alternative (Future without Project Conditions)

5.6.4.1.1 Direct

The No Action Alternative, not implementing the LCA TBBSR Study, would have no direct impacts to submerged aquatic vegetation as no such resources are present on the barrier islands. However, existing conditions, including the continued loss of submerged aquatic vegetation resources within the adjacent Terrebonne Basin estuarine system would persist.

5.6.4.1.2 Indirect

There are no existing submerged aquatic vegetation resources on the Terrebonne Basin barrier islands. Hence, without any action there would be no indirect impacts on the Terrebonne Basin barrier islands to submerged aquatic vegetation resources.

Without any action, approximately 3,220 acres of existing barrier resources from the seven island Terrebonne Basin barrier system (East Timbalier, Timbalier, Trinity, East Island, Wine, Whiskey and Raccoon Island) would likely continue to degrade, fragment and eventually convert into shallow open water bottoms over the 50-year period of analysis. The loss of the Terrebonne Basin barrier island system would consequently result in higher wave energy levels and associated shoreline erosion in the adjacent estuarine bays (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005). Some unknown portions of the adjacent estuarine systems, along with their submerged aquatic vegetation resources, would be transformed into marine open water habitat. It is likely more marine-like conditions would not be conducive to maintaining or establishing submerged aquatic vegetation.

The loss of estuarine submerged aquatic vegetation resources would result in adverse impacts to fish and wildlife habitats (e.g., used for nursery, nesting and feeding habitats). The degradation and eventual loss of estuarine submerged aquatic vegetation resources would also result in the loss of available fish and wildlife habitats which would likely increase competition between and within various fish and wildlife species for diminishing submerged aquatic habitat resources. The loss of estuarine submerged aquatic vegetated habitat would also result in a loss in primary productivity, as well as undetermined impacts to recreation, aesthetic and associated socioeconomic resources.

5.6.4.1.3 Cumulative

The incremental cumulative impacts of the No Action Alternative would be the conversion of some unknown acreage of estuarine submerged aquatic vegetation resources due to the higher wave energy levels and associated shoreline erosion (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005) resulting from the loss of the Terrebonne Basin barrier island system and other coastal Louisiana barrier systems and the resulting conversion from estuarine-like conditions to more marine-like conditions.

These impacts would be offset, to some degree, by the synergistic additive combination of impacts and benefits of coastal barrier island restoration by other Federal, State, local, and private restoration efforts that would protect adjacent estuarine systems, and their associated submerged aquatic vegetation resources, from converting to shallow open water habitats. Coastal barrier islands in Louisiana have been restored, to some degree, by efforts under the CWPPRA program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq.

5.6.4.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.6.4.2.1 Direct

There would be no direct impacts to submerged aquatic wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 5 (NER Plan) would be similar to the No Action Alternative.

5.6.4.2.2 Indirect

There would be no indirect impacts of implementing Alternative 5 (NER Plan) on the Terrebonne Basin barrier islands as there are no submerged aquatic vegetation resources on the barrier islands.

However, compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would restore a net total of 2,781 acres on Raccoon, Timbalier, Trinity, and Whiskey Islands. Restoring these barrier islands to their minimal geormorphological form would result, consistent with Stone and McBride (1998), Stone et al. (2003) and Stone et al. (2005), in the restored barrier islands absorbing wave energy during storms and fair-weather conditions and providing some storm surge protection. Restoring the Terrebonne Basin barrier islands to their geomorphologic form would also contribute to their ecological function of preventing conversion of the estuarine system, especially submerged aquatic vegetation resources, to open water habitat.

Implementing Alternative 5 (NER Plan) would restoring four of the seven Terrebonne barrier islands to their minimal geormorphological form thereby reducing, to some undetermined level, the loss of adjacent estuarine submerged aquatic vegetation resources. This action would prevent/reduce the conversion of some unknown portion of the existing back bay estuarine system and its submerged aquatic vegetation resources into more open water system.

The estuarine submerged aquatic vegetation resources would, in turn, provide important transitional habitat between estuarine and terrestrial environments as well as unique fish and wildlife habitat (e.g., nursery, nesting, and feeding habitats). In addition, preventing/reducing the loss of estuarine submerged aquatic vegetation resources would provide important fish and wildlife habitat which would likely decrease competition between and within various wildlife species for diminishing habitat resources. The prevention/reduction of loss of submerged aquatic vegetated habitat would also result in an undetermined increase in primary productivity compared to the No Action Alternative.

5.6.4.2.3 Cumulative

Cumulative impacts would be the incremental impacts to submerged aquatic vegetation resources from implementing Alternative 5 (NER Plan) when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 5 (NER Plan) would restore the geomorphologic form and ecological function to a net total of 2,781 acres of Terrebonne barrier island resources. Restoration of the geomorphologic form to Raccoon, Whiskey, Trinity and Timbalier Islands would, consistent with Stone (2005), enable these barrier islands to maintain their ecological function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated submerged aquatic vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.4.3 Alternative 11: Whiskey (Plan C)

5.6.4.3.1 Direct

There would be no direct impacts to submerged aquatic wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 11 would be similar to the No Action Alternative.

5.6.4.3.2 Indirect

There would be no indirect impacts of implementing Alternative 11 on the Terrebonne Basin barrier islands as there are no submerged aquatic vegetation resources on the Terrebonne Basin barrier islands.

Compared to the No Action Alternative, indirect impacts to submerged aquatic vegetation resources of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER) but to a lesser degree. Alternative 11 would restore a net total of 527 acres thereby restoring Whiskey Island to its geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially submerged aquatic vegetation resources, to open water habitat.

5.6.4.3.3 Cumulative

These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

Cumulative impacts would be the incremental impacts to submerged aquatic vegetation resources from implementing Alternative 11 when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 11 would restore the geomorphologic form and ecological function to a net total of 527 acres on Whiskey Island. Restoration of the geomorphologic form to Whiskey Island would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated submerged aquatic vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.4.4 Alternative 2: Timbalier (Plan E)

5.6.4.4.1 Direct

There would be no direct impacts to submerged aquatic wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 2 would be similar to the No Action Alternative.

5.6.4.4.2 Indirect

There would be no indirect impacts of implementing Alternative 2 on the Terrebonne Basin barrier islands as there are no submerged aquatic vegetation resources on the Terrebonne Basin barrier islands.

Compared to the No Action Alternative, indirect impacts to submerged aquatic vegetation resources of implementing Alternative 2 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) but to a lesser degree. Alternative 2 would restore a net total of 1,324 acres thereby restoring Timbalier Island to its geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially submerged aquatic vegetation resources, to open water habitat.

5.6.4.4.3 Cumulative

Cumulative impacts would be the incremental impacts to submerged aquatic vegetation resources from implementing Alternative 2 when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 2 would restore the geomorphologic form and ecological function to a net total of 1,324 acres on Timbalier Island. Restoration of the geomorphologic form to Timbalier Island would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated submerged aquatic vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.4.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.6.4.5.1 Direct

There would be no direct impacts to submerged aquatic wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 3 would be similar to the No Action Alternative.

5.6.4.5.2 Indirect

There would be no indirect impacts of implementing Alternative 3 on the Terrebonne Basin barrier islands as there are no submerged aquatic vegetation resources on the Terrebonne Basin barrier islands.

Compared to the No Action Alternative, indirect impacts to submerged aquatic vegetation resources of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) but to a lesser degree. Alternative 3 would restore a net total of 1,851 acres thereby restoring Whiskey and Timbalier Islands to their geomorphologic forms which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially submerged aquatic vegetation resources, to open water habitat.

5.6.4.5.3 Cumulative

Cumulative impacts would be the incremental impacts to submerged aquatic vegetation resources from implementing Alternative 3 when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 3 would restore the geomorphologic form and ecological function to a net total of 1,851 acres on Whiskey and Timbalier Islands. Restoration of the geomorphologic form to Whiskey and Timbalier Islands would, consistent with Stone (2005), enable these barrier islands to maintain their function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated submerged aquatic vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.4.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.6.4.6.1 Direct

There would be no direct impacts to submerged aquatic wetland vegetation as no such resources are present on the Terrebonne Basin barrier islands. Hence, direct impacts of implementing Alternative 4 would be similar to the No Action Alternative.

5.6.4.6.2 Indirect

There would be no indirect impacts of implementing Alternative 4 on the Terrebonne Basin barrier islands as there are no submerged aquatic vegetation resources on the Terrebonne Basin barrier islands.

Compared to the No Action Alternative, indirect impacts to submerged aquatic vegetation resources of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 4 but to a lesser degree. Alternative 4 would restore a net total of 2,140 acres thereby restoring Whiskey, Trinity and Timbalier Islands to their geomorphologic forms which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially submerged aquatic vegetation resources, to open water habitat.

5.6.4.6.3 Cumulative

Cumulative impacts would be the incremental impacts to submerged aquatic vegetation resources from implementing Alternative 4 when added to all past, present and reasonably foreseeable barrier restoration efforts. Alternative 4 would restore the geomorphologic form and ecological function to a net total of 2,140 acres on Whiskey, Trinity and Timbalier Islands. Restoration of the geomorphologic form to Whiskey, Trinity and Timbalier Islands would, consistent with Stone (2005), enable these barrier islands to maintain their function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine marshes and associated submerged aquatic vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.6.5 Invasive Species – Vegetation

5.6.5.1 No Action Alternative (Future without Project Conditions)

5.6.5.1.1 Direct

The No Action Alternative, not implementing the LCA TBBSR Study, would have no direct impacts on invasive vegetation species as no such species are present on the islands.

5.6.5.1.2 Indirect

The No Action Alternative, not implementing the LCA TBBSR Study, would have no indirect impacts on invasive vegetation species as no such species are present on the islands. In addition, it is unlikely that the eventual conversion of the Terrebonne Basin barrier island system to shallow open water would have no indirect impacts on invasive vegetation species within the adjacent Terrebonne Basin estuarine system.

5.6.5.1.3 Cumulative

The No Action Alternative, not implementing the LCA TBBSR Study, would have no cumulative impacts on invasive vegetation species either on the barrier islands or within the adjacent Terrebonne Basin estuarine system.

5.6.5.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.6.5.2.1 Direct

No invasive vegetation species have been found on the Terrebonne Basin barrier islands. Several barrier island restoration projects have been implemented over the past years, with the majority (executed) through the CWPPRA program (e.g. CWPPRA BA-76 Cheniere Ronquille Barrier Island Restoration; BA 40 Riverine Sand Mining/Scofield Island Restoration; BA-38 Barataria Barrier Island Complex Project; TE-27 Whiskey Island Restoration; TE-18 Timbalier island Planting Demonstration; source:http://lacoast.gov/new/Projects/List.aspx accessed September 7, 2010). To date, no invasive species impacts resulting from those projects are known to have been reported or documented. In addition, query of several individuals knowledgeable of Louisiana barrier island ecosystems and current restoration efforts yielded no reports or observations evidencing any displacement of natural vegetative communities by invasive species (personal communication C. Steyer, K. Bahlinger, M. Carloss, M. Hester, G.Linscombe, M. Materne, Irv Mendelssohn, and C. Reid, J. Visser). Consequently, because this alternative would create barrier island habitat with features on a scale similar to existing projects, and would include native species plantings to quickly establish targeted vegetative communities, the anticipated risk of causing conditions favorable to encroachment and impacts by invasive species would be negligible. Hence, direct impacts of implementing Alternative 5 (NER Plan) would be similar to the No Action Alternative.

5.6.5.2.2 Indirect

Indirect impacts of implementing Alternative 5 (NER Plan) would be similar to the No Action Alternative.

5.6.5.2.3 Cumulative

Cumulative impacts of implementing Alternative 5 (NER Plan) would be similar to the No Action Alternative.

5.6.5.3 Alternative 11: Whiskey (Plan C)

5.6.5.3.1 Direct

Direct impacts of implementing Alternative 11 would be similar to the Whiskey Island component of Alternative 5 (NER Plan).

5.6.5.3.2 Indirect

Indirect impacts of implementing Alternative 11 would be similar to the Whiskey Island component of Alternative 5 (NER Plan).

5.6.5.3.3 Cumulative

Cumulative impacts of implementing Alternative 11 would be similar to the Whiskey Island component of Alternative 5 (NER Plan).

5.6.5.4 Alternative 2: Timbalier (Plan E)

5.6.5.4.1 Direct

Direct impacts of implementing Alternative 2 would be similar to the Timbalier Island component of Alternative 5 (NER Plan).

5.6.5.4.2 Indirect

Indirect impacts of implementing Alternative 2 would be similar to the Timbablier Island component of Alternative 5 (NER Plan).

5.6.5.4.3 Cumulative

Cumulative impacts of implementing Alternative 2 would be similar to the Timbalier Whiskey Island component of Alternative 5 (NER Plan).

5.6.5.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.6.5.5.1 Direct

Direct impacts of implementing Alternative 3 would be similar to the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan).

5.6.5.5.2 Indirect

Indirect impacts of implementing Alternative 3 would be similar to the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan).

5.6.5.5.3 Cumulative

Cumulative impacts of implementing Alternative 3 would be similar to the Whiskey Island component of Alternative 5 (NER Plan).

5.6.5.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.6.5.6.1 Direct

Direct impacts of implementing Alternative 4 would be similar to the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan).

5.6.5.6.2 Indirect

Indirect impacts of implementing Alternative 4 would be similar to the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan).

5.6.5.6.3 Cumulative

Cumulative impacts of implementing Alternative 4 would be similar to the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan).

5.7 WILDLIFE AND HABITAT

5.7.1.1 No Action Alternative (Future without Project Conditions)

5.7.1.1.1 Direct

The No Action Alternative, not implementing Terrebonne Basin barrier shoreline restoration, would have no direct impacts on wildlife and habitat resources. Existing conditions would persist. The Terrebonne Basin barrier shoreline would continue to degrade, fragment and eventually convert to primarily marine-influenced open water which would continue to adversely impact foraging, nesting, wintering, resting, refugia, and other important wildlife habitats for resident and migratory birds and other wildlife. The dwindling availability of suitable barrier and back barrier marsh habitats for use by wildlife is expected to result in a general decline of wildlife populations throughout the Terrebonne Basin in general, and the Study Area specifically. Direct adverse impacts to wildlife may also result from events such as tropical storms and hurricanes, but are expected to be smaller in comparison to indirect impacts.

5.7.1.1.2 Indirect

The No Action Alternative would continue to degrade, fragment and eventually convert 3,220 acres of existing Terrebonne Basin barrier island beach, dune and intertidal wildlife habitats to marine-dominated open water bottom habitat over the

50-year period of analysis. The loss of the Terrebonne Basin barrier island system would consequently result in higher wave energy levels and associated shoreline erosion in the adjacent estuarine bays (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005). Some unknown portions of the adjacent Terrebonne Basin estuarine systems, along with their wildlife habitat resources, would be transformed into shallow open water habitat.

The loss of 3,220 acres of existing barrier island and adjacent estuarine wildlife habitats would adversely impact important transitional habitat between estuarine and marine environments; essential fish habitat (EFH); unique wildlife habitat (e.g., nursery, nesting, feeding, and roosting habitats); and critical wintering habitat for the threatened piping plover (Britton and Morton, 1989; Day et al. 1989). The continued degradation and eventual loss of wildlife habitat resources would likely increase competition between and within various fish and wildlife species for diminishing barrier and estuarine habitat resources. The loss of vegetated barrier island wetlands and estuarine islands would also result in a loss in primary productivity. In the long-term, as marine-influenced open water replaces transitional barrier island wildlife habitats and shallow open water replaces existing estuarine wildlife habitats, the extent of land-to-water interface would decrease and wildlife productivity would also likely decline.

5.7.1.1.3 Cumulative

The projected loss over all seven of the Terrebonne barrier islands of about 3,220 acres of barrier island wildlife habitat by 2062 would be in synergistic combination with an unknown area of adjacent existing Terrebonne Basin estuarine wildlife habitats converting to open water habitat following the collapse of the Terrebonne Basin barrier shoreline system. Existing barrier and estuarine wildlife habitat would convert to shallow open water thereby causing wildlife species to move to areas that better support their habitat requirements.

Impacts from the loss of the Terrebonne Basin barrier island system and adjacent estuarine system would be in addition to the projected loss of wildlife and habitat resources throughout coastal Louisiana and the Nation. The LCA Study (USACE, 2004) estimated coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year over the next 50 years. Louisiana has lost approximately 1,900 square miles (492,097 ha) of coastal wildlife habitat resources since the 1930's (Dunbar et al. 1992; Barras et al. 1994; Barras et al. 2003). Approximately 10 percent of Louisiana's remaining coastal wetlands would be lost at a rate of approximately 6,600 acres per year (2,672 ha per year) over the next 50 years, resulting in an additional net loss of 328,000 acres (132,794 ha) by 2050 (Barras et al. 2003). Coastal barrier wildlife habitat loss and estuarine wildlife habitat loss in Louisiana has been addressed, to some degree, by efforts under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq.

5.7.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.7.1.2.1 Direct

Compared to the No Action Alternative, direct impacts to wildlife and habitat resources of implementing Alternative 5 (NER Plan) would primarily result from initial construction and re-nourishment construction activities related to placement of borrow material on existing fragmented dune, supratidal, intertidal (gulfside and bayside) and shallow open water habitats that would make these habitats temporarily unavailable and could disrupt or displace wildlife utilizing these habitats. Alternative 5 (NER Plan) would initially restore a total of 5,840 acres on Raccoon, Whiskey, Trinity, and Timbalier Islands including a total of 472 acres of dune, 4,320 acres of supratidal and 1,048 acres of intertidal wildlife habitats for use by various wildlife species.

Alternative 5 (NER Plan) would initially restore a total of 789 acres of wildlife habitat resources on Raccoon Island, including restoration of 239 acres of existing degrading wildlife habitats and creation of an additional 554 acres of wildlife habitats resources. Additional direct impacts would include renourishment at target year 30 (TY30) of 658 acres of beach and dune wildlife habitat resources along Raccoon Island.

Alternative 5 (NER Plan) would initially restore a total of 1,272 acres of wildlife habitat resources on Whiskey Island including restoration of 820 acres of existing degrading wildlife habitat resources and creation of an additional 469 acres of wildlife habitat resources. Additional direct impacts would include renourishment of 929 acres and 905 acres of beach and dune wildlife habitat resources at TY20 and TY 40, respectively.

Alternative 5 (NER Plan) would initially restore a total of 1,149 acres of wildlife habitat resources on Trinity Island including restoration of 582 acres of existing degrading wildlife habitat resources and creation of an additional 585 acres of wildlife habitat resources. Additional direct impacts would include renourishment of 1,151 acres of beach and dune wildlife habitat resources at TY25.

Alternative 5 (NER Plan) would initially restore a total of 2,630 acres of wildlife habitat resources on Timablier island including restoration of 979 acres of existing degrading wildlife habitat resources and creation of an additional 1,675 acres of wildlife habitat resources. Additional direct impacts would include renourishment of 1,786 acres of beach and dune wildlife habitat resources at TY 30.

Placement of borrow material would unavoidably bury existing barrier shoreline, dune, marsh, and shallow water bottom wildlife habitat resources. Following placement, consolidation of borrow material would take about one year.

Construction of the terminal groin on Raccoon Island would result in 2 acres of these existing shallow water bottoms to be permanently unavailable for use by wildlife.

Migratory Bird and Colonial Nesting Bird Impacts

The USACE Biological Assessment (Appendix A) and the USFWS Biological Opinion (Appendix A) provide more detailed description of impacts to migratory birds and colonial nesting wading birds. Construction activities could disturb or potentially result in a "Take" of colonial-nesting wading birds, terns, gulls, skimmers, shorebirds, or brown pelicans during the estimated 2,480-day construction period. The Migratory Bird Treaty Act of 1918, as amended (MBTA), established a Federal prohibition, unless permitted by regulations, to:

> *"pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported carry, or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time, or in any manner, any migratory bird, included in the terms of this convention … for the protection of migratory birds … or any part, nest, or egg of any such bird."* (16 U.S.C. 703)

All colonial nesting, wading and water birds, and shorebirds are protected by the MBTA. The MBTA prohibits "Take" of these species and Executive Order 13186 of 2001(Responsibilities of Federal Agencies to Protect Migratory Birds) requires that actions by Federal agencies be designed to avoid and minimize impacts to migratory birds. The MBTA prohibits the capture or lethal take of migratory birds; however, the MBTA does not prohibit harassment of migratory birds.

The USFWS and LDWF requires 1,000-ft "no work" areas around active colonial wading-bird nesting colonies during the nesting season (February 15 through September 1). However, the extended length of construction for Alternative 5 (NER Plan), estimated 2,480-day construction period, will require the USACE to continue coordinating with the USFWS and LDWF in order to determine appropriate prevention and abatement procedures to prevent the disturbance and/or takings of nesting birds.

The key to deterring colonial wading birds and other shorebirds from establishing active nesting colonies is timing, persistence, organization, and diversity of abatement measures. The USACE will develop a Nesting Prevention Plan, in coordination with the USFWS and LDWF, that outlines known habitat conditions of the Study Area, expected and potential colonial wading birds and other migratory birds, regulatory overview of Federal and State statutes relating to the implementation of a Nesting Prevention Plan, proposed abatement methods and techniques, safety and communication plans, ambient noise study implementation, monitoring of the Study Area, and reporting the status of the abatement measures.

All abatement measures would be conducted by biologists familiar with colonial wading bird ecology and with proposed abatement methods (e.g., stationary and active audio and visual repellents and others). Prior to and during the nesting season, the Study Area would be inspected by qualified personnel for the presence of nesting colonies during the nesting season. In addition to surveillance, nesting prevention measures would be employed to discourage and prevent wading birds from nesting within a 1,000 ft range of the Study Areas. Active nesting prevention measures would be coordinated with the USFWS and LDWF and likely required from January to September during the year of construction.

If measures to prevent colonial nesting bird populations are not successful in the Study Area, construction-related activities that would occur within 1,000 ft of a colony could be restricted to the non-nesting period, which in this region generally extends from September 1 to February 15, depending on the species present. This restriction would likely pose significant problems to construction activity schedules. If wading bird nesting colonies become established in the Study Area, the 1,000 ft buffer must be maintained unless coordination with the USFWS indicates that the buffer zone may be reduced based on the species present or an agreement is reached with USFWS that allows a modified process to be adopted.

Most of the Terrebonne Basin barrier shoreline is designated as critical wintering habitat for the endangered piping plover (Federal Register, Vol. 66, No. 132). The Endangered Species Act of 1973 (ESA), as amended, prohibits unauthorized taking of endangered or threatened species. Section 7 of the ESA requires Federal agencies to ensure that any action authorized, funded or carried out by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat. The USACE will continue to closely coordinate with the USFWS and LDWF in determining specific actions to avoid and minimize potential impacts to these species and their critical habitat. Therefore, abatement measures to prevent colonial wading-bird nesting should not disturb interior least terns or piping plovers on their wintering habitat.

Louisiana State law also protects species listed as threatened or endangered under the ESA, or species determined by the secretary of the LDWF to be threatened or endangered. The brown pelican and interior least tern are listed as State endangered; piping plover is listed as State threatened. The taking of any State threatened or endangered species is prohibited by State law; therefore, abatement measures to prevent colonial wading-bird nesting should not disturb brown pelicans, interior least terns or piping plovers on their critical wintering habitat.

In order to minimize potential impacts to migratory bird species, the sequencing of barrier island construction could also allow these birds to temporarily relocate to nearby suitable habitat within the Study Area. For example, the proposed beach and dune components of Whiskey and Trinity Island would be constructed before the marsh templates. Once construction of the beach and dune are completed on these two islands, construction would begin on the marsh templates. At that point, the beaches would begin to recover. Raccoon Island would remain undisturbed during sediment placement on Whiskey and Trinity and thus would provide suitable habitat for displaced birds. Furthermore, East Island (which is a continuation of Trinity Island) and East Timbalier (which is adjacent to Timbalier Island) are not part of the proposed restoration efforts for Alternative 5 (NER Plan) and would therefore also provide suitable habitat for the birds during construction of the other islands. Prey species smothered by dune and beach creating activities would re-colonize in the Study boundary within two years following completion of construction activities (USFWS, 2010a). Therefore, by the time construction activities commence on Raccoon Island, the benthic communities on the Whiskey and Trinity Island beaches should be in the recovery phase.

During the preconstruction and engineering (PED) phase, the USACE will continue to coordinate with the USFWS and LDWF to further assess construction sequencing and determine the feasibility of staggering construction such that only one island is disturbed at any point in time. This would minimize disturbance to the piping plover during construction and maintain an abundance of critical wintering habitat within the immediate vicinity of the construction area.

Staggered implementation of renourishment events would also be considered to minimize potential adverse impacts to colonial-nesting wading birds, terns, gulls, skimmers, shorebirds, or brown pelicans. However, as with initial construction, staggering construction could significantly delay project implementation and completion.

5.7.1.2.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 5 (NER Plan) would be a net increase of 2,781 acres with 2,883 AAHUs of important and essential vegetated wildlife habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery and other life requirements; increased vegetation growth and productivity; and reduced inter- and intra-specific species competition between resident and non-resident fish and wildlife species for limited coastal vegetation.

Alternative 5 (NER Plan) would restore and rehabilitate dune, supratidal and intertidal coastal barrier habitats for use by various wildlife species; reduce conversion of these habitats to marine-dominated open water habitat; and provide higher quality EFH, especially nursery habitat, for several species, including brown and white shrimp, and blue crab. Vegetative plantings would contribute to reestablishing a variety of wetland species that would further aid in sediment trapping and barrier island stabilization. Vegetative productivity would likely increase due to increased in vegetated acres on the barrier islands. Important stopover habitats used by migrating neotropical birds would be restored and sustained for future use over the 50-year period of analysis. Compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would delay the conversion of important barrier wildlife habitats to marine-dominated open water habitats over the 50-year period of analysis.

In addition, compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would restore Raccoon, Timbalier, Trinity, and Whiskey Islands to their minimal geormorphological form which would result, consistent with Stone and McBride (1998), Stone et al. (2003) and Stone et al. (2005), in the restored barrier islands absorbing wave energy during storms and fair-weather conditions and providing some storm surge protection. Restoring these four barrier islands to their geomorphologic form would also contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially wildlife habitat resources, to shallow open water habitat.

The protected estuarine wetland vegetation resources would, in turn, provide important transitional habitat between estuarine and terrestrial environments as well as unique wildlife habitat (e.g., nursery, nesting, feeding, and roosting habitats). In addition, preventing/reducing the loss of estuarine wildlife habitat resources would provide important wildlife habitat which would likely decrease competition between and within various wildlife species for diminishing habitat resources. The prevention/reduction of loss of wildlife habitats would also result in an undetermined increase in primary productivity compared to the No Action Alternative.

Implementing Alternative 5 (NER Plan) would also restore a portion of the natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur) thereby reducing, to some unknown extent, the annual economic loss to Louisiana and the nation (after Van Heerden and DeRouen 1997). Furthermore, the proposed barrier shoreline restoration would contribute to the "Cajun" culture and its people thereby indirectly impacting the State's economy and advancing by some unknown extent, the economic development of the State of Louisiana..

5.7.1.2.3 Cumulative

Cumulative impacts would be the incremental impact from implementing Alternative 5 (NER Plan) when added to all past, present and reasonably foreseeable similar barrier wildlife and habitat restoration efforts. Alternative 5 (NER Plan) would restore a net total of 2,781 acres with 2,883 AAHUs of dune, supratidal, intertidal (gulfside and bayside) and shallow open water wildlife habitats which would be in addition to impacts and benefits for overall net acres of barrier wildlife habitat resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts.

In addition, Alternative 5 (NER Plan) would restore the geomorphologic form to Raccoon, Whiskey, Trinity and Timbalier Islands that would, consistent with Stone (2005), enable these barrier islands to maintain their ecological function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine wildlife habitat resources. These restoration efforts would be in addition to other ongoing Federal, State and local restoration efforts. Coastal barrier land loss in Louisiana has been addressed, to some degree, by efforts under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq. TY50..

5.7.1.3 Alternative 11: Whiskey (Plan C with renourishment)

5.7.1.3.1 Direct

Compared to the No Action Alternative, direct impacts to wildlife and habitat resources of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including initial restoration of a total 1,272 acres with 678 AAHUs with 65 acres of dune, 830 acres of supratidal, 377 acres of intertidal wildlife habitat resources on Whiskey Island.

5.7.1.3.2 Indirect

Compared to the No-Action Alternative, indirect impacts to wildlife and habitat resources of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER). Alternative 11 would restore a net total of 527 acres of wildlife habitat resources with 0 net acres dune, 164 net acres supratidal, and 363 net acres of intertidal wildlife habitat resources over the 50-year period of analysis. In addition, Alternative 11 would restore Whiskey Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially wildlife habitat resources, to open water habitat.

5.7.1.3.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 11 restoring a net total of 527 acres with 678 AAHUs of wildlife and habitat resources on Whiskey Island.

Alternative 11 would also restore the minimal geomorphologic form to Whiskey Island that would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.7.1.4 Alternative 2: Timbalier (Plan E)

5.7.1.4.1 Direct

Compared to the No Action Alternative, direct impacts to wildlife and habitat resources of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan), including initial restoration of a total 2,630 acres with 1,110 AAHUs with 215 acres of dune, 2,346 acres of supratidal, 69 acres of intertidal wildlife habitat resources on Timbalier Island.

5.7.1.4.2 Indirect

Compared to the No-Action Alternative, indirect impacts to wildlife and habitat resources of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan). Alternative 2 would restore a net total of 1,324 acres of wildlife habitat resources with 0 net acres dune, 236 net acres supratidal, and 1,088 net acres of intertidal wildlife habitat resources over the 50-year period of analysis. In addition, Alternative 2 would restore Timbalier Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially wildlife habitat resources, to open water habitat).

5.7.1.4.3 Cumulative

Cumulative impacts would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 2 restoring a net total of 1,324 acres with 1,100 AAHUs of wildlife and habitat resources on Timbalier Island.

Alternative 2 would also restore the minimal geomorphologic form to Timbalier Island that would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.7.1.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.7.1.5.1 Direct

Compared to the No Action Alternative, direct impacts to wildlife and habitat resources of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands component of Alternative 5 (NER Plan), including initial restoration of a total 3,902 acres with 1,778 AAHUs with 280 acres of dune, 3176 acres of supratidal, 446 acres of intertidal wildlife habitat resources on Whiskey and Timbalier Islands.

5.7.1.5.2 Indirect

Compared to the No-Action Alternative, indirect impacts to wildlife and habitat resources of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan). Alternative 3 would restore a net total of 1,851 acres of wildlife habitat resources with 0 net acres dune, 400 net acres supratidal, and 1,451 net acres of intertidal wildlife habitat resources over the 50-year period of analysis. In addition, Alternative 3 would restore Whiskey and Timbalier Islands to their minimal geomorphologic form which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially wildlife habitat resources, to open water habitat.

5.7.1.5.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 3 restoring a net total of 1,851 acres with 1,778 AAHUs of wildlife and habitat resources on Whiskey and Timbalier Islands.

Alternative 3 would also, restore the minimal geomorphologic form to Whiskey and Timbalier Islands that would, consistent with Stone (2005), enable these barrier islands to maintain their function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.7.1.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) /Timbalier (Plan E)

5.7.1.6.1 Direct

Compared to the No Action Alternative, direct impacts to wildlife and habitat resources of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands component of Alternative 5 (NER Plan), including initial restoration of a total 5,051 acres with 2,406 AAHUs with 409 acres of dune, 3,632 acres of supratidal, 1,010 acres of intertidal wildlife habitat resources on Whiskey, Trinity and Timbalier Islands.

5.7.1.6.2 Indirect

Compared to the No-Action Alternative, indirect impacts to wildlife and habitat resources of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan). Alternative 4 would restore a net total of 2,140 acres of wildlife habitat resources with 0 net acres dune, 490 net acres supratidal, and 2,140 net acres of intertidal wildlife habitat resources over the 50-year period of analysis. In addition, Alternative 4 would restore Whiskey, Trinity and Timbalier Islands to their minimal geomorphologic form which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially wildlife habitat resources, to open water habitat.

5.7.1.6.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 4 restoring a net total of 2,140 acres with 2,406 AAHUs of wildlife and habitat resources on Whiskey, Trinity and Timbalier Islands.

Alternative 4 would also, restore the minimal geomorphologic form to Whiskey, Trinity and Timbalier Islands that would, consistent with Stone (2005), enable these barrier islands to maintain their function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts

5.8 Aquatic Resources

5.8.1 Benthic

5.8.1.1 No Action Alternative (Future without Project Conditions)

5.8.1.1.1 Direct

The No Action Alternative, not implementing the LCA TBBSR Study, would have no direct impacts on benthic resources and would result in the persistence of existing conditions.

5.8.1.1.2 Indirect

The No Action Alternative would result in the conversion of approximately 3,220 acres of existing Terrebonne Basin barrier island beach, dune and marsh habitats to water bottoms. Conversion of existing barrier island beach, dune and marsh habitat to water bottom habitat would include degradation and loss of important and essential fish and wildlife habitats used for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements; reduction in productivity; degradation and loss of EFH, especially transitional habitat between estuarine and marine environments; degradation and loss of stopover habitat for migrating neotropic birds; and increased inter- and intra-specific competition between resident and migratory fish and wildlife species for decreasing coastal barrier island resources.

The loss of the Terrebonne Basin barrier shoreline system would result in higher wave energy levels and associated shoreline erosion to the adjacent Terrebonne Basin estuarine bays (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005). Some unknown portions of the adjacent estuarine systems, along with their various habitat resources, would be transformed into shallow open water habitat.

Although conversion of 3,220 acres of existing barrier habitat and an unknown acreage of adjacent estuarine habitats to water bottoms would provide additional habitat for benthic organisms, the conversion would decrease available nutrients and detritus and result in the conversion of primarily estuarine-dependent benthic species assemblages to more marine-dominated (in the case of the barrier islands) and open water benthic species assemblages.

5.8.1.1.3 Cumulative

Cumulative impacts to benthic resources would be the synergistic effect of the No-Action Alternative of converting 3,220 acres of existing Terrebonne Basin barrier island habitats to water bottoms, along with the additive combination of approximately 10% of Louisiana's remaining coastal wetlands being converted to water bottoms at a rate of 6,600 acres per year over the next 50 years, resulting in an additional net loss of 328,000 acres by 2050 (Barras et al. 2003). This widespread habitat conversion would decrease available nutrients and detritus and result in the conversion of primarily estuarine-dependent benthic species assemblages to more marine-dominated (in the case of the barrier islands) and open water benthic species assemblages.

These impacts would be offset, to some degree, by the additive combination of impacts and benefits for overall acres of water bottoms impacted by other Federal, State, local, and private restoration efforts. Coastal water bottoms in Louisiana have been impacted, to some degree, by efforts under the CWPPRA program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq.

These impacts would be offset, to some degree, by the synergistic additive combination of impacts and benefits of coastal barrier island restoration by other Federal, State, local, and private restoration efforts that would restore barrier island resources and, in turn, protect adjacent estuarine systems and their associated benthic resources from converting to shallow open water habitats. Coastal barrier islands in Louisiana have been restored, to some degree, by efforts under the CWPPRA program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq..

5.8.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

Compared to the No Action Alternative, direct impacts of implementing Alternative 5 (NER Plan) to benthic organisms would primarily occur during the dredging of fill material from offshore borrow areas and placement of borrow material within the Study Area. Construction of the terminal groin on Raccoon Island would directly impact a total of 2 acres of Gulf of Mexico water bottoms

Initial construction would directly impact a total of 2,498 acres of borrow site water bottoms and benthic organisms utilizing these areas including: 744 acres at the South Pelto-6; 1,187 acres at Ship Shoal, 31 acres at Whiskey 3a (12 ft depth); 366 acres at Whiskey 3a (20 ft depth); 87 acres at New Cut, and 83 acres at Raccoon Island. Renourishment would directly impact a total of 1,222 acres of borrow site water bottoms and benthic organisms utilizing these areas including 1,196 acres at Ship Shoal and 26 acres at South Pelto.

A total of 3,283 acres of existing water bottoms would be converted to beach, dune and marsh barrier habitats during initial construction. Renourishment would impact 1,633 acres of water bottoms and associated benthic organisms.

Dredging and placement of borrow material, as well as placement of rock over 2 acres for construction of the terminal groin on Raccoon Island, could destroy any slow-moving or sessile benthic organisms found within the borrow areas, within the barrier island restoration/creation areas, or within the footprint of the terminal groin at Raccoon Island. However, more mobile benthic species would likely be displaced to more suitable habitats.

Special precautions would be taken in the design and placement of borrow material to minimize disturbance to the benthic communities and maximize their potential for recolonization and recovery. Examples of measures to avoid and minimize potential adverse impacts to benthic resources include borrow area size, spacing, limiting cut depths and dredging frequency to maximize recovery of the benthic community.

Borrow Area Impacts

Potential impacts to benthic communities from mining Ship Shoal were reported in Stone et al. (2009) with findings later published in Dubois et al. (2009), Grippo et al. (2009), and Grippo et al. (2010). Summaries of findings from Stone et al. (2009) are were presented in Section 1.5.1.9. These studies provided baseline information to better understand the ecological services provided by Ship Shoal and to predict disturbance caused by sand mining.

Dubois et al. (2009) predict that the benthic macrofauna at Ship Shoal would be “strongly affected and slow to recover” from sand mining. Sand mining would cause a shift in species dominance to “disturbance specialists” that are fast-growing, small, have rapid reproduction rates and body growth which enables them to colonize disturbed habitats. This could lead to a reduction in biomass which would indirectly impact higher trophic levels (Dubois et al. (2009).

Physical changes to Ship Shoal, such as water depth and mean particle size, and turbidity resulting from dredging activities would also likely affect the benthic community composition and influence primary production. Grippo et al (2009) suggest that benthic microalgae may have higher biomass than phytoplankton on Ship Shoal and contribute significantly to the shoal’s food web. Changes in primary production (impact to the microalgae community) and particle size could reduce the benthic community biomass and alter the species composition which could affect higher trophic levels. Furthermore, Grippo et al. (2009) suggest that the benthic larvae spawned on Ship Shoal could help to recolonize the nearby areas impacted by the seasonal hypoxic zone. In addition, Ship Shoal offers a “hypoxia refuge” for benthic species as well as an important foraging ground for fish and large crustaceans, especially blue crabs that feed on the benthic invertebrates (Grippo et al. 2009).

Grippo et al. (2009) conclude that the effects of sand mining activities on Ship Shoal benthos “*would likely last for months to years and effects may extend to shoal-dependent nekton by food web interactions*”. These authors conclude that Ship Shoal and other sandy shoals offshore of Louisiana play a vital ecological role in the ecology of the northern Gulf of Mexico and offer more than mineral resources.

Borrow Material Placement Impacts

Placement of borrow material for barrier shoreline restoration/creation would directly impact and destroy any slow-moving or sessile benthic organisms found within the intertidal footprints of the restoration sites. More mobile benthic species utilizing these areas would likely be displaced to more suitable habitats. Other direct impacts to the benthos would be localized and confined to construction areas such as fill templates and access channels. However, the prolific nature of the benthic community is expected to recolonize within 1-2 years following construction.

5.8.1.2.1 Indirect

Compared to the No Action Alternative, primarily indirect impacts of implementing Alternative 5 (NER Plan) would be a net increase of 2,118 acres of intertidal barrier habitats used not only by benthic organisms but also by various fish and wildlife species for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements; increased vegetation growth and productivity; and reduced inter- and intra-specific species competition between resident and non-resident fish and wildlife species for limited coastal vegetation. Alternative 5 (NER Plan) would restore and rehabilitate dune, supratidal and intertidal vegetated coastal barrier habitats; reduce conversion of these habitats to open water habitat; and provide higher quality EFH, especially nursery habitat, for several species, including brown and white shrimp, and blue crab. Vegetative plantings would contribute to re-establishment of a variety of wetland species that would further aid in sediment trapping. Vegetative productivity would likely increase due to increased vegetated acres of barrier habitats. Important stopover habitats used by migrating neotropical birds would be restored and sustained for future use over the 50-year period of analysis. Compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would delay the conversion of barrier habitats to open water habitats over the 50-year period of analysis.

Borrow Area Impacts

Indirect impacts to benthic organisms caused by implementing Alternative 5 (NER Plan) are presented above as direct and indirect impacts involve food web dynamics and shifts of benthic species composition resulting from physical disturbance of dredging as well as the environmental changes that follow such as changes in water depths, turbidity, and sediment characteristics.

Placement Impacts

Indirect impacts to benthic organisms would primarily be related to dredging and placement of borrow material for barrier shoreline restoration/creation and renourishment and placement of stone for creation of the terminal groin at Raccoon Island. Construction of the terminal groin at Raccoon Island would result in approximately 2 acres of water bottoms no longer available for use by benthic organisms.

Short-term disturbance to benthic species during dredging and placement would likely occur including: increased turbidity, temperature and biological oxygen demand (BOD); and decreased dissolved oxygen due to hydraulic dredging, marsh creation, and placement of shoreline protection activities. Some smothering of benthic organisms may also occur from the resettlement of the dredge plume, but these impacts would be minimized through the use of silt curtains or other construction measures to minimize dredging impacts. However, indirect impacts would be generally localized and temporary. Waters would return to ambient conditions following construction.

Dredging and placement activities could also cause temporary habitat degradation to existing water bottoms used by benthos for various life requirements. Any such impacts would initially cause increased inter- and intra-specific competition between various benthic species for nearby available habitat resources. There could also be a shift in species composition to those benthic species more tolerant of disturbance. However, any such impacts would be temporary as benthos would likely quickly re-colonize areas disturbed by dredging activities.

Actions taken to reduce potential impacts during construction could include the use of silt curtains and retention dikes to minimize the effects of runoff, overland flow, and sediment movement and erosion into adjacent waterways and marshes. These measures could also help to restrict the extent of increases in turbidity and suspended particulates to the immediate construction area.

Transitional barrier habitats restored by Alternative 5 (NER Plan) would indirectly benefit benthic resources by providing increased dissolved organic compounds and detritus that would, in turn, provide food and energy resources for benthic organisms. This would eventually increase local epifauna which, in turn, would help reduce turbidity, regenerate ammonia and phosphorous, and serve as important sources of food for birds, nekton, and people (Day et al. 1989).

Other Indirect Impacts

Dredging activities, especially at Ship Shoal, could potentially alter wave dynamics, thereby changing onshore storm-wave impacts, possibly leading to greater shoreline erosion. However, Stone et al. (2004) indicates that removal of Ship Shoal sands for barrier/coastal restoration efforts would not significantly influence wave conditions in the nearshore because the expected increase in wave energy is limited to the leeward flank of the shoal. For near-shore borrow areas, proposed borrow sites would be designed to minimize the potential to alter wave dynamics (including sufficient distance from the existing shoreline).

Other Indirect Impacts

Other indirect impacts could include: marine organisms that presently utilize the gulf bottom substrates (especially benthos) would have to adapt to changes in gulf bottom topography; restoration construction activities could cause short-term disruption of commercial and recreational fishing; and alteration of gulf water bottoms may change littoral drift dynamics; creation of depressions, furrows, and pits could impact recolonization by the benthic community (Nairn et al 2004). The primary concern is the potential for ridge and shoal type features to deflate or be smoothed out where borrow deposits are accessed on an ongoing basis. This could lead to large-scale impacts to biological communities (Nairn et al. 2004). However, Stone et al. (2004) indicates that removal of Ship Shoal sands for barrier/coastal restoration efforts would not significantly influence wave conditions in the nearshore because the expected increase in wave energy is limited to the leeward flank of the shoal.

In addition, the MMS, International Activities and Marine Minerals Division is charged with management of Federal Outer Continental Shelf (OCS) sand and gravel resources that would be used for beach nourishment to repair storm damage and protect against sea-level rise. To reduce potential environmental damage associated with long-term and large-scale use of these resources, a project was funded by MMS to design a comprehensive physical and biological monitoring program for sand-mining activities.

Alternative 5 (NER Plan) would restore Whiskey, Raccoon, Trinity and Timbalier Islands to their minimal geomorphologic form which would contribute to their ecological functions of preventing conversion of the adjacent Terrebonne Basin estuarine system to open water habitat.

Implementing Alternative 5 (NER Plan) would restore a portion of the natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur) thereby reducing, to some unknown extent, the annual economic loss to Louisiana and the nation (after Van Heerden and DeRouen 1997). Furthermore, the proposed barrier shoreline restoration would contribute to the "Cajun" culture and its people thereby indirectly impacting the State's economy and advancing by some unknown extent, the economic development of the State of Louisiana.

5.8.1.2.2 Cumulative

Cumulative impacts of implementing Alternative 5 (NER Plan) on benthic resources would include dredging impacts to a total of 3,720 acres of water bottoms (2,498 acres initially; 1,222 acres for renourishment) and placement of borrow material for barrier island restoration over a total of 4,884 acres (3,283 acres initially; 1,601 acres renourishment) in synergistic combination with other impacts and benefits to benthic resources for overall net acres of barrier shorelines restored by other Federal, State, local, and private restoration efforts.

5.8.1.3 Alternative 11: Whiskey (Plan C with renourishment)

5.8.1.3.1 Direct

Compared to the No Action Alternative, direct impacts to benthic organisms caused by implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan). Initial construction would remove a total of 10,340,701 cy of sediments from a total of 535 acres of borrow site water bottoms including: 487 acres at Ship Shoal, and 48 acres at Whiskey Area 3a. Renourishment would remove a total of 16,599,548 cy of borrow material from a total of 859 acres at Ship Shoal; with 9,413,143 cy removed from 487 acres at TY20 and 7,186,405 cy from 372 acres at TY40.

A total of 469 acres of existing water bottoms would be converted to beach, dune and marsh barrier habitats during initial construction. Renourishment would impact 823 acres of water bottoms and associated benthic organisms.

5.8.1.3.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including restoring 363 net acres of intertidal habitat suitable for use by benthic and other fish and wildlife organisms, over the 50-year period of analysis. In addition, Alternative 11 would restore Whiskey Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system to open water habitat.

5.8.1.3.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 11 restoring a net total of 527 acres of barrier habitats suitable for benthic and other fish and wildlife organisms on Whiskey Island. Alternative 11 would also, restore the minimal geomorphologic form to Whiskey Island that would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.8.1.4 Alternative 2: Timbalier (Plan E)

5.8.1.4.1 Direct

Compared to the No Action Alternative, direct impacts to benthic organisms caused by implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan). Initial construction would remove a total of 25,214,803 cy of sediments from a total of 1,375 acres of borrow site water bottoms including: 613 acres at South Pelto – 6 and 762 acres at Whiskey – 3 (beach and marsh). Renourshiment at TY30 would remove a total of 531,329 cy of borrow material from, 26 acres at South Pelto – 6 borrow site.

A total of 1,675 acres of existing water bottoms would be converted to beach, dune and marsh barrier habitats during initial construction. Renourishment would impact 202 acres of water bottoms and associated benthic organisms.

5.8.1.4.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) including restoring a net total of 1,088 net acres of intertidal habitat suitable for use by benthic and other fish and wildlife organisms, over the 50-year period of analysis. In addition, Alternative 2 would restore Timbalier Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system to open water habitat.

5.8.1.4.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 2 restoring a net total of 1,324 acres of barrier habitats suitable for benthic and other fish and wildlife organisms on Timbalier Island. Alternative 2 would also, restore the minimal geomorphologic form to Timbalier Island that would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.8.1.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.8.1.5.1 Direct

Compared to the No Action Alternative, direct impacts to benthic organisms caused by implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan). Initial construction would remove a total of 35,381,587 cy of borrow material from a total of 1,535 acres of water bottoms in the offshore borrow areas including 487 acres at Ship Shoal; 613 acres at the South Pelto; 39 acres at Raccoon Island; and 396 acres at Whiskey Area. Renourishment would remove a total of 17,130,877 cy from a total of 885 acres of water bottoms in offshore borrow areas including 27 acres at South Pelto and 859 acres at Ship Shoal.

A total of 2,144 acres of existing water bottoms on Whiskey and Timbalier Islands would be converted to beach, dune and marsh barrier habitats during initial construction. Renourishment would impact 1,025 acres of water bottoms and associated benthic organisms.

5.8.1.5.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) including restoring a net total of 1,088 net acres of intertidal habitat suitable for use by benthic and other fish and wildlife organisms, over the 50-year period of analysis. In addition, Alternative 3 would restore Whiskey and Timbalier Islands to their minimal geomorphologic form which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system to open water habitat.

5.8.1.5.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 3 restoring a net total of 1,851 acres of barrier habitats suitable for benthic and other fish and wildlife organisms on Whiskey and Timbalier Islands. Alternative 3 would also, restore the minimal geomorphologic form to Whiskey and Timbalier Islands that would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.8.1.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.8.1.6.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan). Initial construction would remove a total of 65,985,063 cy of borrow material from a total of 1,998 acres of water bottoms in the offshore borrow areas including 803 acres at Ship Shoal; 613 acres at the South Pelto; 147 acres at New Cut; and 396 acres at Whiskey Area 3a. Renourishment would remove a total of 21,440,567 cy from a total of 1,108 acres of water bottoms in offshore borrow areas including 26 acres at South Pelto and 1082 acres at Ship Shoal.

A total of 2,729 acres of existing water bottoms on Whiskey, Trinity and Timbalier Islands would be converted to beach, dune and marsh barrier habitats during initial construction. Renourishment would impact 1,562 acres of water bottoms and associated benthic organisms.

5.8.1.6.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 3 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) including restoring a net total of 1,650 net acres of intertidal habitat suitable for use by benthic and other fish and wildlife organisms, over the 50-year period of analysis. In addition, Alternative 3 would restore Timbalier Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system to open water habitat.

5.8.1.6.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 2 restoring a net total of 2,140 acres of barrier habitats suitable for benthic and other fish and wildlife organisms on Timbalier Island. Alternative 2 would also, restore the minimal geomorphologic form to Timbalier Island that would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.8.2 Plankton

5.8.2.1 No Action Alternative (Future without Project Conditions)

5.8.2.1.1 Direct

The No Action Alternative, not implementing the LCA TBBSR Study, would have no direct impacts on benthic resources and would result in the persistence of existing conditions.

5.8.2.1.2 Indirect

The No Action Alternative would result in continued degradation, fragmentation and eventual conversion of approximately 3,220 acres of existing Terrebonne Basin barrier island beach, dune and marsh habitats to marine-dominated water bottoms.

Plankton populations respond to changes in environmental conditions (Day et al. 1989). In particular, changes in salinity and nutrients can result in changes in plankton abundance and community structure. The conversion of the Terrebonne Basin barrier shoreline to marine-dominated water bottoms would result in changes to plankton abundance and community structure.

Human population growth throughout coastal Louisiana would likely result in greater nutrient flux to coastal waterbodies, via an increase in sewerage discharges, increased storm water runoff and increased use of fertilizers thereby impacting nutrient flux in the system. Increased nutrient loads on coastal waterbodies could cause further deterioration of water quality in eutrophic lakes and bays, at times resulting in algal blooms, some of which could be noxious, thereby resulting in a shift in community structure towards dominance by one or several species (Day et al. 1989).

The loss of the Terrebonne Basin barrier shoreline system would result in higher wave energy levels and associated shoreline erosion in the adjacent Terrebonne Basin estuarine bays (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005). Some unknown portions of the existing adjacent estuarine systems would be transformed into open water habitat. This loss of barrier habitats and estuarine habitats would result in a decrease of available nutrients and detritus, which could lead to the conversion of primarily estuarine-dependent plankton species assemblages to more marine-dominant and open water plankton species assemblages.

Conversion of existing barrier island beach, dune and marsh habitat to water bottom habitat would also include degradation and loss of important and essential fish and wildlife habitats used for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements; reduction in productivity; degradation and loss of EFH, especially transitional habitat between estuarine and marine environments; degradation and loss of stopover habitat for migrating neotropic birds; and increased inter- and intra-specific competition between resident and migratory fish and wildlife species for decreasing coastal barrier island resources.

In addition, loss of the Terrebonne Basin barrier shoreline system would indirectly impact natural services (e.g., recreation, aesthetics and water purification) and productivity (fish, shellfish and fur) resulting in undetermined potential economic losses to Louisiana and the nation (after Van Heerden and DeRouen 1997). There would also be unknown adverse indirect impacts to the culture and people of Louisiana that utilize the various coastal resources dependent upon plankton food-web.

5.8.2.1.3 Cumulative

Cumulative impacts to plankton resources would be the synergistic effect of the No-Action Alternative of converting 3,220 acres of existing Terrebonne Basin barrier island habitats to marine-dominated water bottoms, along with the additive combination of approximately 10% of Louisiana's remaining coastal wetlands being converted to water bottoms at a rate of 6,600 acres per year over the next 50 years, resulting in an additional net loss of 328,000 acres by 2050 (Barras et al. 2003). These habitat conversions would result in changes to plankton abundance and community structure. However, these impacts would be offset, to some degree, by the additive combination of impacts and benefits for overall plankton resources impacted by other Federal, State, local, and private restoration efforts. Coastal plankton resources in Louisiana have been impacted, to some degree, by efforts under the CWPPRA program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq.

5.8.2.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.8.2.2.1 Direct

Compared to the No Action Alternative, direct impacts to plankton resources of implementing Alternative 5 (NER Plan) would be localized and short-term adverse impacts, including mortality of some plankton populations, due to construction activities of terminal groin at Raccoon Island, dredging activities at borrow sites as well as placement of borrow for barrier island restoration. During initial construction and re-nourishment a total of 1,1048 acres and 1,601 acres, respectively, of water bottoms and fragmented barrier habitat would be converted to beach, dune and marsh barrier habitats.

During construction, there would be a localized and short-term decrease in available dissolved oxygen; an increase in turbidity, temperature and biological oxygen demand (BOD). Following construction and dredging operations, the area would return to ambient conditions and be re-colonized by plankton populations.

5.8.2.2.2 Indirect

Plankton serve several important roles in estuarine systems (Day et al. 1989). A large number of benthic and nektonic adults spend part of their life in the zooplankton, and as such the plankton stage influences the distribution and abundance of adult populations. In addition, phytoplankton productivity is a major source of primary food-energy for most estuarine ecosystems. Implementation of Alternative 5 (NER Plan) would restore and re-nourishment a net total of 2,781 acres of transitional barrier habitats which would enhance and increase, to some undetermined level, aquatic productivity and nutrient transformation functions. An increase in the export of dissolved organic compounds and detritus from the created and re-nourished barrier islands would benefit local plankton populations by increasing the planktonic food web. Some local plankton populations would be displaced due to construction of barrier islands. Barrier island restoration would result in a long-term loss of shallow open water habitats available for plankton use.

However, there is an abundance of shallow open water habitat throughout the Study Area for use by planktonic resources.

5.8.2.2.3 Cumulative

Cumulative impacts to plankton resources of implementing Alternative 5 (NER Plan) would primarily be associated with the incremental impacts of restoring a net total of 2,781 acres of the Terrebonne Basin barrier shoreline system along with the synergistic effect and combination of impacts and benefits for overall net acres of barrier shoreline created, nourished, and protected by other Federal, State, local, and private restoration efforts. Implementing Alternative 5 (NER Plan) would synergistically interact with these other restoration projects to provide important and essential energy inputs to the planktonic food web throughout coastal Louisiana.

5.8.2.3 Alternative 11: Whiskey (Plan C with renourishment)

5.8.2.3.1 Direct

Compared to the No Action Alternative, direct impacts to plankton resources of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan). During initial construction and re-nourishment a total of 377 acres and 813 acres, respectively, of water bottoms and fragmented barrier habitat would be converted to beach, dune and marsh barrier habitats.

5.8.2.3.2 Indirect

Compared to the No-Action Alternative, indirect impacts to plankton resources of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan). Alternative 11 would restore and re-nourish a net total of 527 acres of transitional barrier habitats which would enhance and increase, to some undetermined level, aquatic productivity and nutrient transformation functions thereby benefiting local plankton populations.

5.8.2.3.3 Cumulative

Cumulative impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the synergistic impacts of restoring a net total of 527 acres on Whiskey Island along with the synergistic effect and combination of impacts and benefits for overall net acres of barrier shoreline created, nourished, and protected by other Federal, State, local, and private restoration efforts.

5.8.2.4 Alternative 2: Timbalier (Plan E)

5.8.2.4.1 Direct

Compared to the No Action Alternative, direct impacts to plankton resources of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan). During initial construction and re-nourishment a total of 69 acres and 191 acres, respectively, of water bottoms and fragmented barrier habitat would be converted to beach, dune and marsh barrier habitats.

5.8.2.4.2 Indirect

Compared to the No-Action Alternative, indirect impacts to plankton resources of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan). Alternative 2 would restore and re-nourish a net total of 1,324 acres of transitional barrier habitats which would enhance and increase, to some undetermined level, aquatic productivity and nutrient transformation functions thereby benefiting local plankton populations.

5.8.2.4.3 Cumulative

Cumulative impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) including the synergistic impacts of restoring a net total of 1,324 acres on Timbalier Island along with the synergistic effect and combination of impacts and benefits for overall net acres of barrier shoreline created, nourished, and protected by other Federal, State, local, and private restoration efforts.

5.8.2.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.8.2.5.1 Direct

Compared to the No Action Alternative, direct impacts to plankton resources of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan). During initial construction and re-nourishment a total of 446 acres and 1,004 acres, respectively, of water bottoms and fragmented barrier habitat would be converted to beach, dune and marsh barrier habitats.

5.8.2.5.2 Indirect

Compared to the No-Action Alternative, indirect impacts to plankton resources of implementing Alternative 3 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan). Alternative 3 would restore and re-nourish a net total of 1,851 acres of transitional barrier habitats which would enhance and increase, to some undetermined level, aquatic productivity and nutrient transformation functions thereby benefiting local plankton populations.

5.8.2.5.3 Cumulative

Cumulative impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) including the synergistic impacts of restoring a net total of 1,851 acres on Whiskey and Timbalier Islands along with the synergistic effect and combination of impacts and benefits for overall net acres of barrier shoreline created, nourished, and protected by other Federal, State, local, and private restoration efforts.

5.8.2.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.8.2.6.1 Direct

Compared to the No Action Alternative, direct impacts to plankton resources of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan). During initial construction and re-nourishment a total of 1,010 acres and 1,532 acres, respectively, of water bottoms and fragmented barrier habitat would be converted to beach, dune and marsh barrier habitats.

5.8.2.6.2 Indirect

Compared to the No-Action Alternative, indirect impacts to plankton resources of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER). Alternative 3 would restore and re-nourish a net total of 2,140 acres of transitional barrier habitats which would enhance and increase, to some undetermined level, aquatic productivity and nutrient transformation functions thereby benefiting local plankton populations.

5.8.2.6.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) including the synergistic impacts of restoring a net total of 2,140 acres on Whiskey, Trinity and Timbalier Islands along with the synergistic effect and combination of impacts and benefits for overall net acres of barrier shoreline created, nourished, and protected by other Federal, State, local, and private restoration efforts.

5.9 Fisheries

5.9.1.1 No Action Alternative (Future without Project Conditions)

5.9.1.1.1 Direct

The No Action Alternative, not implementing Terrebonne Basin barrier shoreline restoration, would have no direct impacts on fisheries resources. Existing conditions would persist.

5.9.1.1.2 Indirect

The No Action Alternative would result in the conversion of approximately 3,220 acres of existing Terrebonne Basin barrier island transitional habitats to water bottom habitats. The loss of the Terrebonne Basin barrier island system would consequently result in higher wave energy levels and associated shoreline erosion in the adjacent estuarine bays (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005). Some unknown portions of the adjacent estuarine systems, along with their wetland resources, would be transformed into open water habitat.

Conversion of existing barrier island beach, dune and marsh habitats to water bottom habitat would include degradation and loss of important and essential fish and wildlife habitats used for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements; reduction in productivity; degradation and loss of EFH, especially transitional habitat between estuarine and marine environments; degradation and loss of stopover habitat for migrating neotropic birds; and increased inter- and intra-specific competition between resident and migratory fish and wildlife species for decreasing coastal barrier island resources. Indirect impacts to fisheries may result from the expected continuation of land loss and further loss of habitat supportive of estuarine and marine fishery species. In the short-term, land loss and predicted sea level changes are likely to increase open water habitats available to marine species. Overall local fish populations could be impacted due to the lack of nursery and spawning areas that would no longer be present in the Study Area due to decreases in inner marsh and marsh edge, estuarine water column and mud, sand, and shell substrate habitats.

In the long-term, as open water replaces barrier and estuarine wetland habitats and the extent of marsh-to-water interface begins to decrease, fishery productivity is likely to decline (Rozas and Reed 1993; Minello et al. 1994). This may already be happening in the Terrebonne estuary. Browder et al. (1989) predicted that brown shrimp catches in Barataria, Timbalier, and Terrebonne basins would peak around the year 2000 and may fall to zero within 52 to 105 years.

Additional indirect impacts resulting from the loss of Terrebonne Basin barrier islands and adjacent estuarine wetlands would include undetermined losses of natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur). This would result in an undetermined economic and cultural loss to Louisiana and the Nation (Van Heerden and DeRouen, 1997).

5.9.1.1.3 Cumulative

The incremental cumulative impacts of the No Action Alternative would be the conversion of 3,220 acres of Terrebonne Basin barrier island transitional habitats to open water bottom habitats over the 50-year period of analysis. In addition, there would be undetermined impacts to adjacent Terrebonne Basin estuarine wetland resources due to the higher wave energy levels and associated shoreline erosion (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005) resulting from Terrebonne Basin barrier island conversion to open water bottom habitat.

Conversion of existing barrier island transitional habitats to water bottom habitat would include degradation and eventual loss of important and essential fish habitat thereby impacting fisheries populations to some unknown extent.

These impacts would be offset, to some degree, by the synergistic additive combination of impacts and benefits of coastal barrier island restoration by other Federal, State, local, and private restoration efforts that would restore barrier island transitional habitats. Coastal barrier islands in Louisiana have been restored, to some degree, by efforts under the CWPPRA program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq. Essential fish habitat that supports juvenile fish species will cease to exist in the Study Area once the barrier shoreline and back barrier marsh is no longer present.

5.9.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.9.1.2.1 Direct

Compared to the No Action Alternative, direct impacts to fisheries resources of implementing Alternative 5 (NER Plan) would be localized and short-term adverse impacts due to construction activities of the terminal groin at Raccoon Island, dredging activities at borrow sites and access canals, as well as placement of borrow for barrier island restoration.

Initial construction would directly impact a total of 2,498 acres of borrow site water bottoms including 744 acres at the South Pelto; 1,187 acres at Ship Shoal, 31 acres at Whiskey 3a (12 ft depth); 366 acres at Whiskey 3a (20 ft depth); 87 acres at New Cut, and 83 acres at Raccoon Island. Renourishment would directly impact a total of 1,222 acres of borrow site water bottoms including 1,196 acres at Ship Shoal and 26 acres at South Pelto.

A total of 3,283 acres of existing water bottoms would be converted to barrier island transitional habitats. Dredging and placement of borrow material could destroy any slow-moving or sessile fisheries organisms found within the borrow areas and within the barrier island restoration/creation areas. Sessile or slow moving fisheries resources would also likely suffer some mortality or injury during placement of rocks a the terminal groin at Raccoon Island. Construction activities would also temporarily increase turbidity, temperatures and biological oxygen demand (BOD); and decrease dissolved oxygen. However, following construction, displaced fisheries resources would likely return to the Study Area.

5.9.1.2.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 5 (NER Plan) would be a net increase of 2,781 acres of transitional barrier habitats with 2,883 AAHUs of important and essential transitional habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements; increased vegetation growth and productivity; and reduced inter- and intra-specific species competition between resident and non-resident fish and wildlife species for limited coastal vegetation.

Alternative 5 (NER Plan) would restore and rehabilitate dune, supratidal and intertidal vegetated coastal barrier habitats; reduce conversion of these habitats to open water habitat; and provide higher quality EFH, especially nursery habitat, for several species, including brown and white shrimp, and blue crab. More nutrients and detritus would be added to the food web, thereby increasing fish productivity and providing a benefit to local fisheries. Recreational activities, such as fishing, would also benefit from the increase in fish populations. Important stopover habitats used by migrating neotropical birds would be restored and sustained for future use over the 50-year period of analysis. Compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would delay the conversion of transitional barrier habitats to open water habitats over the 50-year period of analysis.

In addition, compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would restore Raccoon, Timbalier, Trinity, and Whiskey Islands to their minimal geormorphological form would result, consistent with Stone and McBride (1998), Stone et al. (2003) and Stone et al. (2005), in the restored barrier islands absorbing wave energy during storms and fair-weather conditions and providing some storm surge protection. Restoring these four barrier islands to their geomorphologic form would also contribute to their ecological function of preventing conversion of the adjacent estuarine system, especially wetlands resources, to open water habitat.

The long-term sustainability of local fisheries would be more likely with implementation of Alternative 5 (NER) than in the No-Action Alternative. Increased productivity, as a result of increased vegetated barrier habitats would provide indirect benefits to fisheries through an increase in the energy inputs into the food web of the ecosystem in this area.

Louisiana has an extensive and productive oyster lease program, compared to other states, providing more than 50% of the Nation's oyster harvest (USACE 2004). Implementation of Alternative 5 (NER Plan) would be expected to indirectly benefit local oyster populations. Restoration of transitional habitats would provide additional nutrients and detritus that would contribute to sustaining and maintaining local oyster populations as compared to the No-Action Alternative.

Dredging on Ship Shoal could result in the alteration of sediment grain size and potential reduction of infaunal populations which could have a cascading effect on the distribution of certain demersal fish and other epibenthic predators at Ship Shoal due to the depletion of food resources (MMS 2004). Depending on the recovery rate of the benthic communities in the dredged area and the extent of the area dredged, this could have short-term or long-term effects (MMS 2004). However, the proposed borrow areas are designed with consideration to avoid, minimize and reduce potential long-term adverse impacts. It is anticipated that primary effects of dredging would be short-term and related primarily to benthic organisms. It is further anticipated that benthic organisms would recolonize the borrow areas within one to two years.

5.9.1.2.3 Cumulative

Cumulative impacts to fisheries resources of implementing Alternative 5 (NER Plan) would primarily be associated with the incremental impacts of restoring a net total of 2,781 acres of the Terrebonne Basin barrier islands. In addition Alternative 5 (NER Plan) would restore the geomorphologic form to Raccoon, Whiskey, Trinity and Timbalier Islands that would, consistent with Stone (2005), enable these barrier islands to maintain their ecological function of providing important transitional barrier habitat for fisheries resources. These impacts would be in synergistic combination with the impacts and benefits for overall net acres of transitional barrier islands created, nourished, and protected by other Federal, State, local, and private restoration efforts.

5.9.1.3 Alternative 11: Whiskey (Plan C)

5.9.1.3.1 Direct

Compared to the No Action Alternative, direct impacts to fisheries resources of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan). Initial construction would remove a total of 10,340,701 cy of sediments from a total of 535 acres of borrow site water bottoms including: 487 acres at Ship Shoal, and 48 acres at Whiskey Area 3a. Renourishment would remove a total of 16,599,548 cy of borrow material from a total of 859 acres at Ship Shoal; with 9,413,143 cy removed from 487 acres at TY20 and 7,186,405 cy from 372 acres at TY40.

Initial construction would cover approximately 469 acres of water bottoms and fragmented barrier habitats. Renourishment with borrow material from Ship Shoal would directly impact a total of 474 acres and 349 acres of water bottoms and fragmented barrier habitats at TY20 and TY40, respectively

5.9.1.3.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including a net increase of 527 acres of transitional barrier habitats with 678 AAHUs. In addition, Alternative 11 would restore Whiskey Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine wetlands to open water habitat thereby maintaining important transitional estuarine habitat for fisheries resources.

5.9.1.3.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 11 restoring a net total of 527 acres with 678 AAHUs of transitional barrier island habitat resources on Whiskey Island combined with restoring the minimal geomorphologic form and ecological functions to Whiskey Island that would in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.9.1.4 Alternative 2: Timbalier (Plan E)

5.9.1.4.1 Direct

Compared to the No Action Alternative, direct impacts to fisheries resources of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan). Initial construction would remove a total of 25,214,803 cy of sediments from a total of 1,375 acres of borrow site water bottoms including: 613 acres at South Pelto – 6 and 762 acres at Whiskey – 3 (beach and marsh). Renourshiment at TY30 would remove a total of 531,329 cy of borrow material from, 26 acres at South Pelto – 6 borrow site.

Initial construction would cover approximately 1,675 acres of existing water bottoms and fragmented barrier habitats. Renourishment at TY30, with borrow material from South Pelto – 6, would directly impact a total of 202 acres of water bottoms and fragmented barrier habitats

5.9.1.4.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 11 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) including a net increase of 1,324 acres of transitional barrier habitats with 678 AAHUs. In addition, Alternative 2 would restore Timbalier Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine wetlands to open water habitat thereby maintaining important transitional estuarine habitat for fisheries resources.

5.9.1.4.3 Cumulative

Cumulative impacts would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 2 restoring a net total of 1324 acres with 1,100 AAHUs of transitional barrier island habitat resources on Timbalier Island combined with restoring the minimal geomorphologic form and ecological functions to Whiskey Island that would in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.9.1.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.9.1.5.1 Direct

Compared to the No Action Alternative, direct impacts to fisheries resources of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan). Initial construction would remove a total of 35,381,587 cy of borrow material from a total of 2,786 acres of water bottoms in the offshore borrow areas including 487 acres at Ship Shoal; 613 acres at the South Pelto; 39 acres at Raccoon Island; and 762 acres at Whiskey Area. Renourishment would remove a total of 17,130,877 cy from a total of 885 acres of water bottoms in offshore borrow areas including 27 acres at South Pelto and 859 acres at Ship Shoal.

Initial construction would cover a total of 3,752 acres of water bottoms and existing fragmented barrier habitats. Renourishment would directly cover 474 acres at TY 20 and 349 acres at TY30 on Whiskey Island and 202 acres on Timbalier Island at TY40.

5.9.1.5.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) including a net increase of 1,851 acres of transitional barrier habitats with 1,778 AAHUs. In addition, Alternative 3 would restore Whiskey and Timbalier Islands to their minimal geomorphologic form which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine wetlands to open water habitat thereby maintaining important transitional estuarine habitat for fisheries resources.

5.9.1.5.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 3 restoring a net total of 1,851 acres with 1,778 AAHUs of transitional barrier island habitat resources on Whiskey and Timbalier Islands combined with restoring the minimal geomorphologic form and ecological functions to Whiskey and Timbalier Islands that would in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.9.1.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.9.1.6.1 Direct

Compared to the No Action Alternative, direct impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan). Initial construction would remove a total of 44,326,558 cy of borrow material from a total of 1,998 acres of water bottoms in the offshore borrow areas including 814 acres at Ship Shoal; 613 acres at the South Pelto; 39 acres at Raccoon Island; 147 acres at New Cut; and 762 acres at Whiskey Area. Renourishment would remove a total of 21440567 cy from a total of 1,108 acres of water bottoms in offshore borrow areas including 26 acres at South Pelto and 1,082 acres at Ship Shoal.

Initial construction would cover a total of 2,729 acres of water bottoms and existing fragmented barrier habitats. Renourishment would directly cover 464 acres at TY 20 and 349 acres at TY40 on Whiskey Island; 528 acres on Trinity Island at TY 25; and 191 acres on Timbalier Island at TY30.

5.9.1.6.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) including a net increase of 2,140 acres of transitional barrier habitats with 2,406 AAHUs. In addition, Alternative 4 would restore Whiskey, Trinity and Timbalier Islands to their minimal geomorphologic form which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine wetlands to open water habitat thereby maintaining important transitional estuarine habitat for fisheries resources.

5.9.1.6.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 4 restoring a net total of 2,140 acres with 2,406 AAHUs of transitional barrier island habitat resources on Whiskey and Timbalier Islands combined with restoring the minimal geomorphologic form and ecological functions to Whiskey and Timbalier Islands that would in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.10 Essential Fish Habitat (EFH)

5.10.1.1 No Action Alternative (Future without Project Conditions)

5.10.1.1.1 Direct

The No Action Alternative, not implementing coastal barrier system restoration, would have no direct impacts on EFH. Existing conditions would persist.

5.10.1.1.2 Indirect

The No Action Alternative would result in the conversion of approximately 3,220 acres of transitional barrier habitats from East Timbalier, Timbalier, Trinity, East Island, Wine, Whiskey and Raccoon Islands to water bottom habitats over the 50 year period of analysis. The loss of the Terrebonne Basin barrier shoreline system would result in higher wave energy levels and associated shoreline erosion in the adjacent estuarine bays (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005). Some unknown portions of the adjacent Terrebonne Basin estuarine systems, along with their EFH resources – particularly estuarine marsh habitat – a more productive category of EFH, would be transformed into open water habitat, a less productive category of EFH.

Approximately 1,560 acres of existing intertidal back barrier marsh from the seven barrier island system, a more productive category of EFH, would be converted to marine-dominated water bottoms, a less productive EFH category. This loss would continue to adversely impact essential spawning, nursery, nesting, and foraging habitats for commercially and recreationally important species of finfish and shellfish, as well as other aquatic organisms.

The loss of Terrebonne Basin barrier islands would adversely impact important transitional habitat between barrier island and marine environments as well as between estuarine and open water environments. This would result in the loss of unique wildlife habitat (e.g., nursery, nesting, feeding, and roosting habitats); and critical wintering habitat for the threatened piping plover. In addition, the continued degradation and eventual loss of Terrebonne Basin barrier islands and adjacent estuarine wetland resources would result in the loss of fish and wildlife habitat which would likely increase competition between and within various fish and wildlife species for diminishing habitat resources. The loss of vegetated wetlands would also result in a loss in primary productivity.

Without implementation of the proposed barrier island restoration, the conversion of barrier island categories of EFH, such as inner barrier marsh and barrier marsh edge, to marine-dominated water column and mud, sand, or shell substrates is expected to continue. Loss of the Terrebonne Basin barrier island system would result in conversion of adjacent estuarine wetland EFH to water bottoms, water column and mud, sand or shell substrates. This would result in a substantial decrease in the quality of EFH throughout the Study Area and reduce the area's ability to support Federally-managed fisheries species.

Additional indirect impacts of loss of Terrebonne Basin barrier islands and adjacent estuarine wetlands would be include undetermined losses of natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur). This would result in an undetermined economic and cultural loss to Louisiana and the Nation (Van Heerden and DeRouen, 1997).

5.10.1.1.3 Cumulative

Louisiana has lost approximately 1,900 square miles (492,097 ha) of coastal wetlands and barrier habitats, which are important EFH resources, since the 1930's (Dunbar et al. 1992; Barras et al. 1994; Barras et al. 2003). Approximately 10 percent of Louisiana's remaining coastal wetlands and barrier islands would be lost at a rate of approximately 6,600 acres per year (2,672 ha per year) over the next 50 years, resulting in an additional net loss of 328,000 acres (132,794 ha) by 2050 (Barras et al. 2003). Land loss in the Study Area would likely continue at rates similar to present resulting in the projected loss over all seven of the Terrebonne barrier islands of about 3,220 acres. There would likely be a concomitant increase in loss of adjacent estuarine wetlands with loss of the Terrebonne Basin barrier island system. This projected loss would be in addition to the projected loss of barrier islands and other coastal wetland resources throughout coastal Louisiana. The LCA Study (USACE, 2004) estimated coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year over the next 50 years. Barrier island loss, loss of adjacent estuarine wetlands, conversion of existing EFH, sea level change, increased storm intensity, and other natural perturbations are expected to contribute to a decrease in the diversity of EFH most supportive of transitional estuarine habitat and barrier island habitat-dependent species.

5.10.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.10.1.2.1 Direct

Compared to the No Action Alternative, direct impacts to EFH resources of implementing Alternative 5 (NER Plan) would be localized and due primarily to construction activities of the terminal groin at Raccoon Island, dredging activities at borrow sites, as well as placement of borrow for barrier island restoration.

Direct impacts of construction activities would result in the conversion of existing shallow open water and fragmented barrier wetland EFH into more continuous transitional emergent wetlands thereby increasing the quality of EFH within the Raccoon, Whiskey, Trinity and Timbalier Islands.

Dredging would alter existing water bottom (hard sandy shoal EFH) within the borrow areas. Initial construction would directly impact a total of 2,498 acres of borrow site water bottoms including 744 acres at the South Pelto; 1,187 acres at Ship Shoal, 31 acres at Whiskey 3A (12 ft depth); 366 acres at Whiskey 3A (20 ft depth); 87 acres at New Cut, and 83 acres at Raccoon Island. Renourishment would directly impact a total of 1,222 acres of borrow site water bottoms (hard sandy shoal EFH) including 1,196 acres at Ship Shoal and 26 acres at South Pelto. Dredging impacts would be of short duration with water bottoms re-equilibrating and re-settled with benthic fauna within one to two years.

Disruption of the Gulf of Mexico marine habitat EFH associated with borrow areas would temporarily displace the fishery (e.g. dog snapper, lane snapper, red drum, and shrimp) that inhabitants these areas of reefs and hard sand bottoms. Sessile of slow moving benthic organisms within the borrow areas could be destroyed by dredging activities. This would make the borrow areas less suitable for use by benthic or fishery resources. However, these impacts would be temporary. Fishery organisms would likely use the borrow areas shortly after dredging activities cease. Benthic organisms would recolonize the borrow areas within one to two years.

A total of 3,283 acres of existing water bottoms and associated fragmented barrier EFH (intertidal marsh) would be converted to transitional barrier island beach, dune, and intertidal habitats. Alternative 5 (NER Plan) would restore a total of 1,315 acres of intertidal back barrier marsh, a more continuous and higher quality EFH than existing open water and highly fragmented barrier habitat EFH. This conversion of lower quality EFH to higher quality EFH would provide important and essential transitional barrier habitats used by fish and wildlife for spawning, nursery, foraging, cover, and other life requirements. Increased vegetation growth and productivity would also reduce inter- and intra- specific competition between resident and migratory fish and wildlife species for limited coastal vegetation resources.

Dredging and placement activities would result in increased turbidity, coupled with a slight increase in temperature and biological oxygen demand (BOD), and decreased dissolved oxygen. These impacts would be temporary and localized.

The existing open water and highly fragmented intertidal marsh in the barrier island restoration areas consist of fragmented emergent marsh, remnant and active oyster reefs, and sand/shell/hard bottoms within the surrounding estuaries. Species such as red drum; pink, brown, and white shrimp; stone crab; juvenile red snapper; and juvenile Spanish mackerel would be temporarily impacted due to construction of Alternative 5 (NER Plan) (see table 4-8). Although existing EFH would be initially negatively impacted, such impacts would be offset by the restoration of transitional barrier habitats, which are considered a higher-quality EFH.

5.10.1.2.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 5 (NER Plan) would be a net increase of 2,781 acres of transitional barrier habitats with 2,883 AAHUs of important and essential transitional barrier habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements; increased vegetation growth and productivity; and reduced inter- and intra-specific species competition between resident and non-resident fish and wildlife species for limited coastal vegetation.

Alternative 5 (NER Plan) would restore and rehabilitate dune, supratidal and intertidal vegetated coastal barrier habitats; reduce conversion of these habitats to open water habitat; and provide higher quality EFH, especially nursery habitat, for several species, including brown and white shrimp, and blue crab. More nutrients and detritus would be added to the food web, thereby increasing fish productivity and providing a benefit to local fisheries. Recreational activities, such as fishing, would also benefit from the increase in fish populations. Important stopover habitats used by migrating neotropical birds would be restored and sustained for future use over the 50-year period of analysis. Compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would delay the conversion of transitional barrier habitats and associated higher quality EFH to lower quality and more abundant open water habitats over the 50-year period of analysis.

Alternative 5 (NER Plan) would restore a net total of 2,118 acres of intertidal habitats over the 50 year period of analysis. This would improve the quality of some categories of EFH, including essential nursery habitats for many fishery species. Alternative 5 (NER Plan) would not only increase the area extent of higher quality EFH, but would also improve the quality of transitional barrier wetland habitats used by fish for spawning, nursery, forage, cover, and other life requirements. An increase in the acreage of transitional habitat between estuarine and marine environments would result in decreased inter- and intra-specific competition between resident and migratory fish species and would likely sustain a larger variety and greater diversity of fishery species. Some of these fishery species serve as prey to others; therefore, predator populations may be indirectly enhanced as compared to the No-Action Alternative.

The long-term sustainability of local fisheries would be more likely with implementation of Alternative 5 (NER Plan) than in the No-Action Alternative. Increased productivity, as a result of increased vegetated barrier habitats would provide indirect benefits to fisheries through an increase in the energy inputs into the food web of the ecosystem in this area.

Louisiana has an extensive and productive oyster lease program, compared to other states, providing more than 50% of the Nation's oyster harvest (USACE 2004). Implementation of Alternative 5 (NER Plan) would be expected to indirectly benefit local oyster populations. Restoration of transitional habitats would provide additional nutrients and detritus that would contribute to sustaining and maintaining local oyster populations as compared to the No-Action Alternative.

In addition, compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would restore Raccoon, Timbalier, Trinity, and Whiskey Islands to their minimal geormorphological form would result, consistent with Stone and McBride (1998), Stone et al. (2003) and Stone et al. (2005), in the restored barrier islands absorbing wave energy during storms and fair-weather conditions and providing some storm surge protection. Restoring these four barrier islands to their geomorphologic form would also contribute to their ecological function of preventing conversion of the adjacent estuarine wetland EFH resources to open water EFH.

5.10.1.2.3 Cumulative

Cumulative impacts to EFH resources of implementing Alternative 5 (NER Plan) would primarily be associated with the incremental impacts of restoring a net total of 2,781 acres of the Terrebonne Basin barrier islands. Although there would be impacts to marine water bottom EFH associated with dredging a total of 3,720 acres of water bottoms for initial construction and re-nourishment, these impacts would likely be of short duration and not significant. In addition Alternative 5 (NER Plan) would restore the geomorphologic form to Raccoon, Whiskey, Trinity and Timbalier Islands that would, consistent with Stone (2005), enable these barrier islands to maintain their ecological function of providing important transitional barrier habitat for fisheries resources. These impacts would be in synergistic combination with the impacts and benefits for overall net acres of transitional barrier islands created, nourished, and protected by other Federal, State, local, and private restoration efforts. Cumulative impacts would be the synergistic effect with the additive combination of impacts and benefits for overall net acres of barrier habitats restored by other Federal, State, local, and private restoration efforts. Alternative 5 (NER Plan) would synergistically interact with those other projects to provide higher quality EFH.

5.10.1.3 Alternative 11: Whiskey Plan C (w/ renourishment)

5.10.1.3.1 Direct

Compared to the No Action Alternative, direct impacts to EFH resources of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan). Initial construction would remove a total of 10,340,701 cy of sediments from a total of 535 acres of borrow site water bottoms including: 487 acres at Ship Shoal, and 48 acres at Whiskey Area 3a. Renourishment would remove a total of 16,599,548 cy of borrow material from a total of 859 acres at Ship Shoal; with 9,413,143 cy removed from 487 acres at TY20 and 7,186,405 cy from 372 acres at TY40.

A total of 469 acres of existing water bottoms and associated fragmented barrier EFH (intertidal marsh) would be converted to transitional barrier island beach, dune, and intertidal habitats. Alternative 11 would restore a total of 377 acres of intertidal back barrier marsh, a more continuous and higher quality EFH than existing open water and highly fragmented barrier habitat EFH.

5.10.1.3.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including a net increase of 527 acres of transitional barrier habitats with 678 AAHUs. In addition, Alternative 11 would restore Whiskey Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine wetlands and associate EFH to open water habitat EFH thereby maintaining important transitional estuarine habitat for fisheries resources. Alternative 11 would restore a net total of 363 acres of intertidal habitats over the 50 year period of analysis.

5.10.1.3.3 Cumulative

Cumulative impacts to EFH resources of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) and would be primarily associated with the incremental impacts of restoring a net total of 527 acres on Whiskey Island. Although there would be impacts to marine water bottom EFH associated with dredging a total of 1,394 acres of water bottoms for initial construction and re-nourishment, these impacts would likely be of short duration and not significant. Cumulative impacts would be the synergistic effect with the additive combination of impacts and benefits for overall net acres of barrier habitats, and their associated EFH, restored by other Federal, State, local, and private restoration efforts. Alternative 11 would work cooperatively with those projects to provide higher quality EFH.

5.10.1.4 Alternative 2: Timbalier (Plan E)

5.10.1.4.1 Direct

Compared to the No Action Alternative, direct impacts to EFH resources of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan). Initial construction would remove a total of 25,214,803 cy of sediments from a total of 1,375 acres of borrow site water bottoms including: 613 acres at South Pelto – 6 and 762 acres at Whiskey – 3 (beach and marsh). Renourshiment at TY30 would remove a total of 531,329 cy of borrow material from, 26 acres at South Pelto – 6 borrow site.

Initial construction would cover approximately 1,675 acres of existing water bottoms and fragmented barrier habitats. Renourishment at TY30, with borrow material from South Pelto – 6, would directly impact a total of 202 acres of water bottoms and fragmented barrier habitats.

A total of 1,675 acres of existing water bottoms and associated fragmented barrier EFH (intertidal marsh) would be converted to transitional barrier island beach, dune, and intertidal habitats. Alternative 2 would restore a total of 564 acres of intertidal back barrier marsh, a more continuous and higher quality EFH than existing open water and highly fragmented barrier habitat EFH.

5.10.1.4.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) including a net increase of 1,324 acres of transitional barrier habitats with 1,100 AAHUs. In addition, Alternative 2 would restore Timbalier Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine wetlands and associate EFH to open water habitat EFH thereby maintaining important transitional estuarine habitat for fisheries resources. Alternative 2 would restore a net total of 1,088 acres of intertidal habitats over the 50 year period of analysis.

5.10.1.4.3 Cumulative

Cumulative impacts to EFH resources of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan) and would be primarily associated with the incremental impacts of restoring a net total of 1,324 acres on Timbalier Island. Although there would be impacts to marine water bottom EFH associated with dredging a total of 1,401 acres of water bottoms for initial construction and re-nourishment, these impacts would likely be of short duration and not significant. Cumulative impacts would be the synergistic effect with the additive combination of impacts and benefits for overall net acres of barrier habitats, and their associated EFH, restored by other Federal, State, local, and private restoration efforts. Alternative 2 would work cooperatively with those projects to provide higher quality EFH.

5.10.1.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.10.1.5.1 Direct

Compared to the No Action Alternative, direct impacts to EFH resources of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan). Initial construction would remove a total of 35,381,587 cy of borrow material from a total of 2,786 acres of water bottoms in the offshore borrow areas including 487 acres at Ship Shoal; 613 acres at the South Pelto; 39 acres at Raccoon Island; and 762 acres at Whiskey Area. Renourishment would remove a total of 17,130,877 cy from a total of 885 acres of water bottoms in offshore borrow areas including 27 acres at South Pelto and 859 acres at Ship Shoal.

Initial construction would cover a total of 3,752 acres of water bottoms and existing fragmented barrier habitats. Renourishment would directly cover 474 acres at TY 20 and 349 acres at TY30 on Whiskey Island and 202 acres on Timbalier Island at TY40.

5.10.1.5.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) including a net increase of 1,851 acres of transitional barrier habitats with 1,778 AAHUs. In addition, Alternative 3 would restore Whiskey and Timbalier Islands to their minimal geomorphologic form which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine wetlands and associated EFH to open water habitat EFH thereby maintaining important transitional estuarine habitat for fisheries resources. Alternative 3 would restore a net total of 1,451 acres of intertidal habitats over the 50 year period of analysis.

5.10.1.5.3 Cumulative

Cumulative impacts to EFH resources of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) and would be primarily associated with the incremental impacts of restoring a net total of 1,851 acres on Whiskey and Timbalier Islands. Although there would be impacts to marine water bottom EFH associated with dredging a total of 3,671 acres of water bottoms for initial construction and re-nourishment, these impacts would likely be of short duration and not significant. Cumulative impacts would be the synergistic effect with the additive combination of impacts and benefits for overall net acres of barrier habitats, and their associated EFH, restored by other Federal, State, local, and private restoration efforts. Alternative 3 would work cooperatively with those projects to provide higher quality EFH.

5.10.1.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.10.1.6.1 Direct

Compared to the No Action Alternative, direct impacts to EFH resources of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan). Initial construction would remove a total of 44,326,558 cy of borrow material from a total of 1,998 acres of water bottoms in the offshore borrow areas including 814 acres at Ship Shoal; 613 acres at the South Pelto; 39 acres at Raccoon Island; 147 acres at New Cut; and 762 acres at Whiskey Area 3a. Renourishment would remove a total of 21440567 cy from a total of 1,108 acres of water bottoms in offshore borrow areas including 26 acres at South Pelto and 1082 acres at Ship Shoal.

Initial construction would cover a total of 2,729 acres of water bottoms and existing fragmented barrier habitats. Renourishment would directly cover 464 acres at TY 20 and 349 acres at TY40 on Whiskey Island; 528 acres on Trinity Island at TY 25; and 191 acres on Timbalier Island at TY30.

5.10.1.6.2 Indirect

Compared to the No Action Alternative, indirect impacts of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) including a net increase of 2,140 acres of transitional barrier habitats with 2,406 AAHUs. In addition, Alternative 4 would restore Whiskey, Trinity and Timbalier Islands to their minimal geomorphologic form which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine wetlands and associated EFH to open water habitat EFH thereby maintaining important transitional estuarine habitat for fisheries resources. Alternative 4 would restore a net total of 1,650 acres of intertidal habitats over the 50 year period of analysis.

5.10.1.6.3 Cumulative

Cumulative impacts to EFH resources of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) and would be primarily associated with the incremental impacts of restoring a net total of 2,140 acres on Whiskey, Trinity and Timbalier Islands. Although there would be impacts to marine water bottom EFH associated with dredging a total of 3,106 acres of water bottoms for initial construction and re-nourishment, these impacts would likely be of short duration and not significant. Cumulative impacts would be the synergistic effect with the additive combination of impacts and benefits for overall net acres of barrier habitats, and their associated EFH, restored by other Federal, State, local, and private restoration efforts. Alternative 3 would work cooperatively with those projects to provide higher quality EFH.

5.11 Threatened and Endangered Species

5.11.1.1 No Action Alternative (Future without Project Conditions)

5.11.1.1.1 Direct

The No Action Alternative, not implementing Terrebonne Basin barrier shoreline restoration, would have no direct impacts on listed (endangered or threatened) species or their critical habitat. Existing conditions would persist; listed species would likely continue to be subject to institutional recognition and further regulations and Federal management.

5.11.1.1.2 Indirect

Without any action, approximately 3,220 acres of existing barrier island transitional habitats from the seven island Terrebonne Basin barrier system (East Timbalier, Timbalier, Trinity, East Island, Wine, Whiskey and Raccoon Island) would continue to degrade, fragment and eventually convert into marine-dominated open water bottoms. Loss of the Terrebonne Basin barrier island system would result in higher wave energy levels and associated shoreline erosion in the adjacent estuarine bays (Stone and McBride 1998, Stone et al 2003, and Stone et al. 2005). If the Terrebonne Basin barrier island system is not restored, the adjacent estuarine wetlands would also continue to be converted into open water habitat.

Indirect impacts of not implementing the Terrebonne Basin barrier island restoration features would result in the continued degradation and loss of designated critical wintering habitat and its primary constituents for the threatened piping plover. Other listed species could also be adversely impacted by the loss of the barrier islands including: Gulf sturgeon, green sea turtle, hawksbill sea turtle, Kemp's Ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, and the West Indian manatee. However, the piping plover and sea turtles would most likely be impacted to the greatest extent, as these species utilize the rapidly deteriorating barrier systems.

Loss of the Terrebonne Basin barrier islands and the concomitant conversion of adjacent estuarine transitional wetlands would adversely affect not only listed species but also other fish and wildlife species that utilize the Study Area such as colonial nesting water birds, shorebirds, and the brown pelican. Indirect impacts would include conversion of higher quality EFH (back barrier and estuarine marsh habitat) to lower quality EFH (open water habitat); loss of unique fish and wildlife habitats used for nursery, nesting, feeding, and roosting habitats and other life requirements. The continued degradation and eventual loss of barrier and estuarine wetland resources would result in the loss of fish and wildlife habitat which would likely increase competition between and within various fish and wildlife species for diminishing habitat resources. The loss of vegetated wetlands would also result in a loss in primary productivity. In the long-term, as marine-influenced open water replaces transitional barrier island wildlife habitats and shallow open water replaces existing estuarine wildlife habitats, the extent of land-to-water interface would decrease and wildlife productivity would also likely decline.

Van Heerden and DeRouen (1997) indicate the loss of Louisiana's coastal wetlands, including barrier island and barrier shorelines, was conservatively valued at $1,000/hectare in terms of natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur) resulting in the annual loss to Louisiana and the nation exceeding $150 million every year. Van Heerden and DeRouen father indicate that the people living in the Louisiana coastal zone, the heart of "Cajun" culture, would have the greatest impact on the State's economy; hence, restoring the coast would therefore advance the economic development of the State of Louisiana.

5.11.1.1.3 Cumulative

The projected loss over all seven of the Terrebonne barrier islands of about 3,220 acres of barrier island transitional habitat by 2062 would be in synergistic combination with an unknown area of adjacent existing Terrebonne Basin estuarine habitats converting to open water habitat following the collapse of the Terrebonne Basin barrier shoreline system. Existing barrier and estuarine transitional fish and wildlife habitat would convert to marine dominated shallow open water thereby causing fish and wildlife species to move to areas that better support their habitat requirements. Listed species that would be primarily affected would be the piping plover and sea turtles.

Impacts from the loss of the Terrebonne Basin barrier island system and adjacent estuarine system would be in addition to the projected loss of fish and wildlife and piping plover critical wintering habitat resources throughout coastal Louisiana and the Nation. The LCA Study (USACE, 2004) estimated coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year over the next 50 years. Louisiana has lost approximately 1,900 square miles (492,097 ha) of coastal wildlife habitat resources since the 1930's (Dunbar et al. 1992; Barras et al. 1994; Barras et al. 2003). Approximately 10 percent of Louisiana's remaining coastal wetlands would be lost at a rate of approximately 6,600 acres per year (2,672 ha per year) over the next 50 years, resulting in an additional net loss of 328,000 acres (132,794 ha) by 2050 (Barras et al. 2003). Coastal barrier transitional habitat loss and estuarine transitional habitat loss in Louisiana has been addressed, to some degree, by efforts under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq. area.

5.11.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.11.1.2.1 Direct

Compared to the No Action Alternative, direct impacts to listed species of implementing Alternative 5 (NER Plan) would primarily result from initial construction and re-nourishment construction activities related to placement of borrow material on existing fragmented dune, supratidal, intertidal (gulfside and bayside) and shallow open water habitats that would make these habitats temporarily unavailable and could disrupt or displace listed species utilizing these habitats. Direct impacts of implementing Alternative 5 (NER Plan) on listed species is presented below. A Biological Assessment (Appendix A) and the USFWS Biological Opinion (Appendix B) provide more detailed information.

Piping Plover Impacts

Critical Habitat Impacts

Alternative 5 (NER Plan) would initially restore a total of 3,730 acres of piping plover critical wintering habitat over the four barrier islands including: 619 acres on Raccoon, 624 acres on Whiskey, 434 acres on Trinity, and 2053 acres on Timbalier Island (see Biological Assessment, Appendix A). Beneficial impacts to the piping plover and its critical habitat include restoration of critical wintering habitat and prolonged life of barrier islands, as well as constructing a terminal groin on Raccoon Island that would function to protect critical habitat. Much of the existing barrier island system is sediment-starved, and the proposed action would introduce sediment into the system that would be reworked and redistributed through future storm events, thereby maintaining and/or enhancing the features of critical wintering habitat (i.e. sand and mud flats) that are essential to piping plover conservation.

Apart from the terminal groin on Raccoon Island, the project is not expected to alter the natural longshore sediment transport mechanisms within the Isles Dernieres and Timbalier Islands. Without the terminal groin, the sediment that moves off of Raccoon Island to the west is lost to the shoals and buried by the mud stream from the Atchafalaya. Therefore, the terminal groin on Raccoon Island will not starve other islands in adjacent reaches.

Piping plover critical wintering habitat was assumed to be the unvegetated portion of the dune, supratidal, and gulfward intertidal habitats (personal communication Ms. Brigette Firmin, USFWS August, 2010). The intertidal habitats, such as the beaches, mudflats, and sand flats, provide vital foraging grounds for the piping plover. Unvegetated dune and supratidal habitats function as suitable roosting and sheltering areas. The predicted critical habitat acres are provided in Tables 5-5 through 5-8.

Table 5-5. Predicted Critical Habitat Acreages for Raccoon Island

	Critical Habitat (acres)								
	TY0	TY1	TY5	TY10	TY20	TY30[1]	TY31	TY40	TY50
FWOP[2]	61	61	43	23	10	6	6	0	0
FWP[3]	61	680	295	348	339	183	276	139	133
Net[4]	0	619	253	325	329	178	270	139	133

[1]Renourishment occurs at TY30
[2]FWOP – Future Without Project (i.e. no action)
[3]FWP – Future With Project
[4]Net = FWP – FWOP

Table 5-6. Predicted Critical Habitat Acreages for Whiskey Island

	Critical Habitat (acres)									
	TY0	TY1	TY5	TY10	TY20[1]	TY21	TY30	TY40[1]	TY41	TY50

FWOP[2]	221	220	91	64	47	46	37	0	0	0
FWP[3]	221	843	236	223	127	615	212	89	464	118
Net[4]	0	624	146	159	80	569	174	89	464	118

[1]Renourishment occurs at TY20 and TY40
[2]FWOP – Future Without Project (i.e. no action)
[3]FWP – Future With Project
[4]Net = FWP – FWOP

Table 5-7. Predicted Critical Habitat Acreages for Trinity Island

	Critical Habitat (acres)									
	TY0	TY1	TY5	TY10	TY20	TY25[1]	TY26	TY30	TY40	TY50
FWOP[2]	158	149	110	60	10	6	6	3	0	0
FWP[3]	158	583	238	232	154	123	626	277	170	87
Net[4]	0	434	128	172	145	116	620	274	170	87

[1]Renourishment occurs at TY25
[2]FWOP – Future Without Project (i.e. no action)
[3]FWP – Future With Project
[4]Net = FWP – FWOP

Table 5-8. Predicted Critical Habitat Acreages for Timbalier Island

	Critical Habitat (acres)								
	TY0	TY1	TY5	TY10	TY20	TY30[1]	TY31	TY40	TY50
FWOP[2]	256	258	187	201	99	30	28	5	0
FWP[3]	256	2312	983	1152	1006	587	867	381	227
Net[4]	0	2053	796	952	907	557	839	376	227

[1]Renourishment occurs at TY30
[2]FWOP – Future Without Project (i.e. no action)
[3]FWP – Future With Project
[4]Net = FWP - FWOP

If Alternative 5 (NER Plan) were not constructed and the islands allowed to erode at their current rate, the majority of existing critical habitat over these four islands is expected to disappear by TY40. Alternative 5 (NER Plan) would substantially increase the amount of critical habitat on the islands for each target year over the 50-year period of analysis.

Unavoidable short term impacts to piping plover critical wintering habitat would primarily result from the placement of sediments onto existing beach and dune habitats during construction and renourishment. These activities would smoother existing populations of benthic prey species. Prey species smothered by dune and beach creating activities would re-colonize in these areas within two years once construction activities cease (USFWS, 2010a). The critical habitat values do not account for the required recovery time of these prey species. For example, there will be approximately 867 acres of critical habitat on Timbalier Island immediately after renourishment (i.e. TY31). However, the island will not reach optimal conditions for the piping plover until TY33, once the benthic species have recovered.

Potential impacts that would occur to existing designated critical habitat would be temporary, and would provide for the long-term maintenance and/or enhancement of critical habitat within the Study Area. There would be no permanent impacts to critical habitat that would change the ecological processes that maintain it. However, because an entire island would be affected during a construction event, and because adjacent islands may undergo construction within two years or less, the ability of those islands to provide enough suitable foraging habitat to piping plovers will likely be affected until all construction is completed (USFWS 2010a).

Based on these factors, it is the USACE determination that implementing Alternative 5 (NER Plan) is likely to adversely affect the piping plover and its critical habitat.

<u>Species Impacts</u>:

Under optimal conditions, impacts to piping plovers could be avoided by conducting the proposed activities outside the wintering season. However, construction would likely occur while plovers are present. Due to the magnitude of barrier island erosion and land-loss rates, delaying construction until the non-wintering season could result is considerable degradation to each barrier island foundation and thus require significant increases in fill volume requirements.

Furthermore, delays would be extremely risky because the existing habitats would be more vulnerable to hurricane forces. Therefore, the risks associated with delaying the project are not justified based on the temporary nature of the disturbance. Due to their mobility, piping plovers would be able to avoid areas of temporary disturbance using the abundance of suitable foraging and roosting areas adjacent to the Study Area. For example, East Island, which is a continuation of Trinity Island, currently supports 272 acres of critical habitat. East Timbalier Island and Wine Island collectively provide 259 acres of suitable habitat for piping plover, although the islands have not been technically designated as critical habitat. These three islands are located within the Isle Dernieres and Timbalier Island Ranges, immediately adjacent to the islands in the NER Plan. There is also a considerable amount of critical habitat near the Study boundary. For example, West Belle Pass, Elmers Island, and East Grand Terre are located approximately 15 miles, 25 miles, and 40 miles east of Timbalier Island, respectively. Locust Bayou and the Atchafalaya Delta offer additional critical habitat west of Raccoon Island.

Suitable habitat can also be found at Point au Fer Island and at the numerous pockets and sand and mudflats along coastal Louisiana.

During the Preliminary Engineering and Design (PED) phase, the USACE will assess the feasibility of staggering the construction of the islands such that only one island is disturbed at any point in time. Furthermore, the USACE will attempt to adopt an “every other island” approach to construction. For example, Timbalier Island would be constructed after Whiskey, followed by Trinity and then Raccoon. This will minimize disturbance to the piping plover during construction and maintain an abundance of critical habitat within the immediate vicinity of the disturbed island. By staggering the initial construction of the islands in the NER Plan, the renourishment events would also be staggered. However, constructing the islands in series could significantly delay the completion of the project and inflate project costs.

West Indian Manatee

Manatee occurrences have been regularly reported in the canals and coastline of Louisiana. Collision with boats and barges is one of the primary anthropogenic causes of manateemortalities. To avoid any impacts to the West Indian Manatee, all contract personnel associatedwith the Study will be informed of the potential presence of manatees and the need to avoid collisions with manatees, which are protected under the Marine Mammal Protection Act of 1972and the Endangered Species Act of 1973. All construction personnel will be required to monitor all water-related activities for the presence of manatee(s). Temporary signs will be posted prior to and during all construction/dredging activities to remind personnel to be observant for manatees during active construction/dredging operations or within vessel movement zones (i.e., work area), and at least one sign will be placed where it is visible to the vessel operator. Siltation barriers, if used by the contractor, will be made of material in which manatees could not become entangled, and will be properly secured per technical specifications provided by the manufacture. If a manatee is sighted within 100 yards of the active work zone, special operating conditions will be implemented, including:

- No operation of moving equipment within 50 ft of a manatee
- All vessels will operate at no wake/idle speeds within 100 yards of the work area
- Siltation barriers, if used, will be monitored and re-secured as necessary

Once the manatee has left the 100-yard buffer zone around the work area on its own accord, special operating conditions are no longer necessary, but careful observations will resume. Care will also be taken to avoid entrapment of individuals if any structure is to be installed that could be a barrier or impediment to manatee movement.

By implementing the above-mentioned manatee monitoring and avoidance program, it is the USACE determination that the proposed NER Plan "may affect, but will not likely adversely affect" the endangered West Indian Manatee.

Sea Turtles

Based on professional experience and related CWPPRA project construction methods, it is anticipated that the contractor will use a hydraulic cutterhead dredge and booster pump(s) to excavate sediment from the available offshore borrow area(s) and directly transport it via a submerged sediment pipeline to the islands. Environmental laws protecting sea turtles could possibly require the cessation of work for a limited time if the allowable number of sea turtles mortalities is exceeded during dredging. However, turtles are typically able to avoid cutterhead dredge intakes because the dredges move along the seabed at such a slow speed. Sediment used to construct the containment dikes will be dredged from existing material inside the marsh creation area rather than from offshore borrow areas.

Therefore, dredging operations associated with the containment dikes are not expected to adversely impact sea turtles.

In summary, it is the USACE determination that the borrow area dredging operations "may affect, but will not likely adversely affect" populations of sea turtles in the Study Area. Impacts associated with the actual placement of fill on the islands are discussed below for each species of threatened/endangered sea turtles identified by USFWS.

Green Sea Turtle

Due to the lack of extensive seagrass beds throughout much of coastal Louisiana, and the low incidence of sightings and strandings, it is the Corps' determination that placement of fill on four islands in the NER Plan is expected to have "no effect" on the green sea turtle population.

Hawksbill Sea Turtle

It is the Corps' determination that placement of fill on the four islands in the NER Plan will have "no effect" on hawksbill populations due to its rarity along the Louisiana coast.

Kemp's Ridley Sea Turtle

The proposed NER Plan would provide more suitable inshore habitat for foraging. This habitat type is characterized by lower salinity and high turbidity and organic content, where shrimp and blue crabs are abundant Therefore, it is the Corps' determination that placement of fill on the four islands in the NER Plan "may affect, but will not likely adversely affect" populations of Kemp's ridley sea turtles.

Leatherback Sea Turtle

This pelagic species typically occupies oceanic waters of more than 160 ft (50 m) in depth. Therefore, it is the Corps' determination that placement of fill on the four islands in the NER Plan is expected to have "no effect" on Leatherback sea turtle populations.

Loggerhead Sea Turtle
Nesting loggerhead sea turtles have historically used barrier islands; however, it is doubtful that loggerhead sea turtles nest anywhere on the Louisiana coast. The restoration of Raccoon, Whiskey, Trinity, and Timbalier Island may or may not provide suitable nesting habitat, but suitable nesting habitat is nearly nonexistent due to the current degraded State of these islands. The NER Plan would not negatively affect loggerheads and could potentially provide some benefit to the species by restoring nesting habitat. Therefore, it is the USACE determination that implementation of Alternative 5 (NER Plan) with placement of fill on Raccoon, Whiskey, Trinity, and Timbalier Islands "may affect, but will not likely adversely affect" populations of Loggerhead sea turtles.

Formal Consultation
Compliance with the ESA (7 U.S.C. 136; 16 U.S.C. 460 et seq.) has been coordinated with the USFWS and the NMFS for those species under their respective jurisdictions. The use of recommended primary activity exclusion zones and timing restrictions would be utilized, to the maximum extent practicable, to avoid project construction impacts to any threatened or endangered species or their critical habitat within the Study Area. The USACE will continue to closely coordinate and consult with the USFWS and the NMFS regarding threatened and endangered species under their jurisdiction that may be potentially impacted by the proposed action. Although the West Indian manatee and the Hawksbill, Kemp's ridley, Leatherback, Loggerhead, and Green sea turtles may be found in the Study Area, the only endangered species with a high potential for adverse impacts from the NER Plan is the piping plover. Multi-project research is currently underway to determine the potential for diversion impacts to this species. Formal consultation on the piping plover has been conducted and the USFWS has issued a Biological Opinion (Annex A2). The USACE has agreed to comply with the RPM and the terms and conditions outlined in the Biological Opinion and summarized in Sections 3.6.7.1 and 3.7.7.1.

5.11.1.2.2 Indirect

Compared to the No Action Alternative, implementing Alternative 5 (NER Plan) would restore a net total of 565 acres of critical piping plover wintering habitat over the four barrier islands including: 133 net acres on Raccoon, 118 net acres on Whiskey, 87 net acres on Trinity, and 227 net acres on Timbalier Island.

Alternative 5 (NER Plan) would restore a net total of 2,781 acres with 2,883 AAHUs of dune, supratidal and intertidal (gulfside and bayside) and shallow open water habitats for use by not only the above described listed species, but also other fish and wildlife species. Alternative 5 (NER Plan) would restore the four barrier islands to their minimal geormorphological form resulting, consistent with Stone and McBride (1998), Stone et al. (2003) and Stone et al. (2005), in the restored barrier islands absorbing wave energy during storms and fair-weather conditions and providing some storm surge protection to adjacent estuarine system thereby preventing the conversion of some unknown quantity of this transitional estuarine habitat to shallow open water habitat. Restoring these four barrier islands to their geomorphologic form would also contribute to their ecological function of providing important and critical habitat for some listed species.

Alternative 5 (NER Plan) would reduce conversion of these transitional barrier habitats to marine-dominated open water habitat thereby providing higher quality EFH, especially nursery habitat, for several fishery species, including brown and white shrimp, and blue crab as well as various benthic organisms. Vegetative plantings would contribute to re-establishing a variety of wetland species that would further aid in sediment trapping and barrier island stabilization. Vegetative productivity would likely increase due to increased in vegetated acres on the barrier islands. Important stopover habitats used by migrating neotropical birds would be restored and sustained for future use over the 50-year period of analysis.

Alternative 5 (NER Plan) would also restore vegetation resources would, in turn, provide important transitional habitat between estuarine and terrestrial environments as well as unique habitats (e.g., nursery, nesting, feeding, and roosting habitats). In addition, preventing/reducing the loss of estuarine wildlife habitat resources would provide important fish and wildlife habitat which would likely decrease competition between and within various fish and wildlife species for diminishing habitat resources. The prevention/reduction of loss of barrier habitats would also result in an undetermined increase in primary productivity compared to the No Action Alternative.

Implementing Alternative 5 (NER Plan) would also restore a portion of the natural services (recreation, aesthetics and water purification) and productivity (fish, shellfish and fur) thereby reducing, to some unknown extent, the annual economic loss to Louisiana and the nation (after Van Heerden and DeRouen 1997). Furthermore, the proposed barrier shoreline restoration would contribute to the "Cajun" culture and its people thereby indirectly impacting the State's economy and advancing by some unknown extent, the economic development of the State of Louisiana.

5.11.1.2.3 Cumulative

Cumulative impacts would be the incremental impact from implementing Alternative 5 (NER Plan) when added to all past, present and reasonably foreseeable similar barrier island restoration efforts. Alternative 5 (NER Plan) would restore a net total of 2,781 acres with 2,883 AAHUs of dune, supratidal, intertidal (gulfside and bayside) and shallow open water wildlife habitats which include critical habitat for the piping plover. These impacts would be in addition to impacts and benefits for overall net acres of barrier wildlife habitat resources created, nourished, restored, and/or protected by other Federal, State, local, and private restoration efforts. Cumulative impacts would be similar to Alternative 11, but to lesser extent.

In addition, Alternative 5 (NER Plan) would restore the geomorphologic form to Raccoon, Whiskey, Trinity and Timbalier Islands that would, consistent with Stone (2005), enable these barrier islands to maintain their ecological function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne interior estuarine wildlife habitat resources. These restoration efforts would be in addition to other ongoing Federal, State and local restoration efforts. Coastal barrier land loss in Louisiana has been addressed, to some degree, by efforts under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program, and the beneficial use of dredged material requirements under Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq. TY50.

5.11.1.3 Alternative 11: Whiskey (Plan C)

5.11.1.3.1 Direct

Compared to the No Action Alternative, direct impacts to listed species or their designate critical habitat would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan), including initial restoration of a total 1,272 acres with 678 AAHUs with 65 acres of dune, 830 acres of supratidal, 377 acres of intertidal resources on Whiskey Island. Alternative 11 would initially restore a total of 624 acres of piping plover critical wintering habitat on Whiskey Island.

5.11.1.3.2 Indirect

Compared to the No-Action Alternative, indirect impacts to listed species or their critical habitat of implementing Alternative 11 would be similar to those described for the Whiskey Island component of Alternative 5 (NER). Alternative 11 would restore a net total of 527 acres with 678 AAHUs of transitional barrier habitat resources with 0 net acres dune, 164 net acres supratidal, and 363 net acres of intertidal resources over the 50-year period of analysis. In addition, Alternative 11 would restore Whiskey Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially transitional wetland resources, to open water habitat. Compared to the No Action Alternative, implementing Alternative 11 would restore a net total of 118 acres of piping plover critical wintering habitat on Whiskey Island.

5.11.1.3.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 11 restoring a net total of 527 acres with 678 AAHUs of transitional barrier habitat resources on Whiskey Island, including a net total of 118 acres of piping plover critical wintering habitat.

Alternative 11 would also restore the minimal geomorphologic form to Whiskey Island that would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.11.1.4 Alternative 2: Timbalier (Plan E)

5.11.1.4.1 Direct

Compared to the No Action Alternative, direct impacts to listed species or their designate critical habitat would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan), including initial restoration of a total 2,630 acres with 1,110 AAHUs with 215 acres of dune, 2,346 acres of supratidal, 69 acres of intertidal resources on Timbalier Island. Alternative 2 would initially restore a total of 2,053 acres of piping plover critical wintering habitat on Timbalier Island.

5.11.1.4.2 Indirect

Compared to the No-Action Alternative, indirect impacts to listed species or their critical habitat of implementing Alternative 2 would be similar to those described for the Timbalier Island component of Alternative 5 (NER Plan). Alternative 2 would restore a net total of 1,324 acres with 1,110 AAHUs of transitional barrier habitat resources with 0 net acres dune, 236 net acres supratidal, and 1,088 net acres of intertidal resources over the 50-year period of analysis. In addition, Alternative 2 would restore Timbalier Island to its minimal geomorphologic form which would contribute to its ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially transitional wetland resources, to open water habitat. Compared to the No Action Alternative, implementing Alternative 2 would restore a net total of 227 acres of piping plover critical wintering habitat on Timbalier Island.

5.11.1.4.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey Island component of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 2 restoring a net total of 1,324 acres with 1,110 AAHUs of transitional barrier habitat resources on Timbalier Island, including a net total of 227 acres of piping plover critical wintering habitat.

Alternative 2 would also restore the minimal geomorphologic form to Timbalier Island that would, consistent with Stone (2005), enable this barrier island to maintain its function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.11.1.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.11.1.5.1 Direct

Compared to the No Action Alternative, direct impacts to listed species or their designate critical habitat would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan), including initial restoration of a total 3,902 acres with 1,778 AAHUs with 280 acres of dune, 3176 acres of supratidal, 446 acres of intertidal wildlife habitat resources on Whiskey and Timbalier Islands. Alternative 3 would initially restore a total of 2,677 acres of piping plover critical wintering habitat on Whiskey and Timbalier Islands.

5.11.1.5.2 Indirect

Compared to the No-Action Alternative, indirect impacts to listed species or their critical habitat of implementing Alternative 3 would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan). Alternative 3 would restore a net total of 1,851 acres of transitional barrier habitat resources with 0 net acres dune, 400 net acres supratidal, and 1,451 net acres of intertidal habitat resources over the 50-year period of analysis. In addition, Alternative 3 would restore Whiskey and Timbalier Islands to their minimal geomorphologic form which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially transitional wetland resources, to open water habitat. Compared to the No Action Alternative, implementing Alternative 3 would restore a net total of 345 acres of piping plover critical wintering habitat on Whiskey Island.

5.11.1.5.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey and Timbalier Islands components of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 3 restoring a net total of 1,851 acres with 1,778 AAHUs of transitional barrier habitat resources on Whiskey and Timbalier Islands, including a net total of 345 acres of piping plover critical wintering habitat.

Alternative 3 would also restore the minimal geomorphologic form to Whiskey and Timbalier Islands that would, consistent with Stone (2005), enable these barrier islands to maintain their function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.11.1.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.11.1.6.1 Direct

Compared to the No Action Alternative, direct impacts to listed species or their designate critical habitat would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan), including initial restoration of a total 5,051 acres with 2,406 AAHUs with 409 acres of dune, 3,632 acres of supratidal, 1,010 acres of intertidal wildlife habitat resources on Whiskey, Trinity and Timbalier Islands. Alternative 4 would initially restore a total of 3,111 acres of piping plover critical wintering habitat on Whiskey and Timbalier Islands.

5.11.1.6.2 Indirect

Compared to the No-Action Alternative, indirect impacts to listed species or their critical habitat of implementing Alternative 4 would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan). Alternative 4 would restore a net total of 2,140 acres of transitional barrier habitat resources with 0 net acres dune, 490 net acres supratidal, and 2,140 net acres of intertidal habitat resources over the 50-year period of analysis. In addition, Alternative 4 would restore Whiskey, Trinity and Timbalier Islands to their minimal geomorphologic form which would contribute to their ecological function of preventing conversion of the adjacent Terrebonne Basin estuarine system, especially wildlife habitat resources, to open water habitat system, especially transitional wetland resources, to open water habitat. Compared to the No Action Alternative, implementing Alternative 3 would restore a net total of 432 acres of piping plover critical wintering habitat on Whiskey, Trinity and Timbalier Islands.

5.11.1.6.3 Cumulative

Cumulative impacts would be similar to those described for the Whiskey, Trinity and Timbalier Islands components of Alternative 5 (NER Plan) including the synergistic interaction of the impacts of Alternative 4 restoring a net total of 2,140 acres with 2,406 AAHUs of transitional barrier habitat resources on Whiskey, Trinity and Timbalier Islands, including a net total of 432 acres of piping plover critical wintering habitat.

Alternative 4 would also restore the minimal geomorphologic form to Whiskey, Trinity and Timbalier Islands that would, consistent with Stone (2005), enable these barrier islands to maintain their function of absorbing wave energy during storms and fair-weather conditions and provide some undetermined level of storm surge protection and reduction of wave potential for the Terrebonne Basin estuarine wetland vegetation resources. These incremental impacts would be in addition to similar impacts for other barrier island restoration efforts across the Louisiana coastal area by other Federal, State, and local barrier island restoration efforts.

5.12 Cultural and Historic Resources

Various prehistoric archaeological studies of the barrier island zones of the Mississippi Deltas have been summarized by Nowak, et al. (2010) and Goodwin, et al.(1991). They indicate that the primary settlement areas for prehistoric peoples were natural levees and other elevated features associated with bayous, particularly following delta or distributary abandonment. Some settlement has been reported from the barrier islands, but it is postulated that the islands and beaches were mainly exploited for their shellfish resources. Historically, permanent settlement on the Terrebonne Basin Barrier Islands occurred in the nineteenth century, but ceased mid-century, when the modest resort community on Isle Dernieres was destroyed by a hurricane in 1856 (Sallenger, 2009). Subsequent human habitation has been restricted to seasonal fishing camps and petroleum processing and transmission facilities.

On July 29, 2010, the USACE executed a Programmatic Agreement among the USACE, CPRA, SHPO, and ACHP, pursuant to 36 CFR § 800.14(b)(1). The Programmatic Agreement establishes the procedures for consultation, identification of historic properties, and assessment and resolution of adverse effects (Appendix F). The execution and implementation of the Programmatic Agreement fulfills USACE obligations under Section 106 of the National Historic Preservation Act of 1966, as amended. The Programmatic Agreement will be implemented during PED.

5.12.1.1 No Action Alternative (Future without Project Conditions)

5.12.1.1.1 Direct

The No Action Alternative, not implementing coastal barrier system restoration, would present no immediate direct impacts to historic properties. Any undiscovered or unreported cultural resources or traditional cultural properties would remain intact and in their current State of preservation.

5.12.1.1.2 Indirect

As the barrier islands and interior marshes erode and/or subside, prehistoric cultural resources could become exposed to elements or inundated, putting them at a greater risk of damage or destruction. However, Nowak (ibid.) points out that no prehistoric archaeological sites have been recorded within the areas of potential effect (APE) for the islands of the Study. The historic cultural resources, particularly those associated with the petroleum industry, will become increasingly vulnerable to adverse impacts over time from storm damage, as the barrier islands and marshes continue to degrade.

5.12.1.1.3 Cumulative

As described in the preceding paragraph, both barrier island and inland cultural resources, in the broadest sense, will continue to be adversely affected and become increasingly vulnerable over time. This vulnerability extends to settled areas located along the natural levees that extend into the basin, including established communities such as Cocodrie. The latter is a center for recreational fishing and the site of the Louisiana Universities Marine Consortium (LUMCON), a renowned and significant educational and scientific research facility

5.12.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.12.1.2.1 Direct

Nowak (ibid.) indicates that there is a low probability for significant prehistoric archaeological sites or prehistoric watercraft, historic archaeological sites or standing structures within the Raccoon Island and Whiskey Island APEs. Within the Raccoon Island APE, a high probability for historic shipwrecks is indicated near Raccoon Point, while a moderate probability for such resources is present to the east of this area. A low probability for historic shipwrecks is indicated along the entire Gulf Coast of the island, since waters south of the shoreline within the APE were subaerially exposed until the mid-twentieth century. The northwestern portion of the Whiskey Island APE has a moderate probability for historic shipwrecks, but areas within the APE south and west of this region were subaerially exposed until the mid-twentieth century; thus, they should be considered to have low potential for historic shipwrecks. A Phase I submerged cultural resources remote sensing investigation was conducted by R. Christopher Goodwin and Associates, Inc. within the vicinity of Whiskey Island (Nowak et al. 2010b). Thirteen (13) targets potentially representing submerged cultural resources were identified. However, none of the magnetic anomalies that compose those targets could be associated with side scan sonar contacts, suggesting that all thirteen (13) targets are buried. There will be no direct impacts to historic properties if the targets representing potential historic properties are avoided. A Phase 1 remote sensing submerged cultural resource investigation of the Raccoon and Timbalier Island areas having a high and moderate potential for historic shipwrecks shall be completed prior to construction activities, and any targets representing potential historic shipwrecks shall be avoided. No historic properties have been identified in the Raccoon Island, Trinity Island, and Timbalier Island APEs; therefore, no direct impacts to historic properties are anticipated.

5.12.1.2.2 Indirect

Shoreline stabilization and dune and marsh restoration on the four islands will reduce ongoing land loss and erosion in the Study Area behind those the islands, which will reduce impacts to cultural resources in the interior marshes and uplands (Stone & McBride, 1998; Stone, et al., 2005).

5.12.1.2.3 Cumulative

The cumulative impacts of implementing Alternative 5 would be similar to the previously-described indirect impacts. Over time, as the islands themselves are eroded, their mitigative effects will diminish. The proposed periodic renourishment will restore the protection they afford the interior marshes and uplands.

5.12.1.3 Alternative 11: Whiskey (Plan C)

5.12.1.3.1 Direct

There is a low probability for significant prehistoric archaeological sites or prehistoric watercraft, historic archaeological sites or standing structures within the Whiskey Island APE. The northwestern portion of the Whiskey Island APE has a moderate probability for historic shipwrecks, but areas within the APE south and west of this region were subaerially exposed until the mid-twentieth century; thus, they should be considered to have low potential for historic shipwrecks. A Phase I submerged cultural resources remote sensing investigation was conducted by R. Christopher Goodwin and Associates, Inc. within the vicinity of Whiskey Island (Nowak et al. 2010b). Thirteen (13) targets exhibiting the potential to represent submerged cultural resources were identified, although none of the magnetic anomalies that compose those targets could be associated with side scan sonar contacts, suggesting that all thirteen (13) targets are buried. There will be no direct impacts to historic properties if the targets representing potential historic properties are avoided.

5.12.1.3.2 Indirect

Because Whiskey Island is so close to the interior marshes (approximately 1 mile to the north) its shoreline stabilization and dune and marsh creation will provide protection to the cultural resources associated with those wetlands. Such protection will not benefit the interior marshes and uplands in the lee of the remaining Terrebonne barrier islands.

5.12.1.3.3 Cumulative

The cumulative impact of Whiskey Island restoration will be the above-referenced protection afforded the adjacent marsh and upland areas. With the anticipated renourishment events at TY20 and TY40 such protection would last through the 50-year period of analysis. Should there be other Federal, State, local, and private restoration efforts to provide complementary protection for the barrier islands, it would extend to providing protection to inland cultural resources.

5.12.1.4 Alternative 2: Timbalier (Plan E)

5.12.1.4.1 Direct

There is a low probability for significant prehistoric archaeological sites or prehistoric watercraft, historic archaeological sites or standing structures within the Timbalier Island APE; however, there is a moderate probability for historic shipwrecks. A portion of the Timbalier Island APE was investigated recently by Coastal Environments, Inc. (Kelley et al. 2009). No significant cultural resources were identified during that study. As a result, only the areas immediately adjacent to but outside of the footprint of the aforementioned Coastal Environments, Inc. investigation can be considered to have a moderate potential for historic shipwrecks. A Phase 1 submerged cultural resource investigation of the area having a moderate potential for historic shipwrecks shall be completed prior to construction activities, and any targets representing potential historic shipwrecks shall be avoided. No historic properties have been identified in the Timbalier Island APE; therefore, no direct impacts to historic properties are anticipated.

Both the South Pelto Borrow Area 6 and the Whiskey Island Restoration Borrow Area 3 have been investigated, and targets representing potentially significant cultural resources will be avoided. The borrow area limits and avoidance areas are included in Appendix L. There will be no direct impacts to historic properties if the targets representing potential historic properties are avoided.

5.12.1.4.2 Indirect

Because Timbalier Island is well-removed from the marshes and uplands to its north, indirect impacts of implementing Alternative 2 would be minimal, and would be confined to protection of nearby petroleum industry infrastructure.

5.12.1.4.3 Cumulative

Cumulative impacts of implementing Alternative 2 would be the above-referenced protection to nearby petroleum industry infrastructure. With the anticipated renourishment at TY30 this protection should last through the 50-year period of analysis for the Study. As with Alternative 11, should there be other Federal, State, local, and private restoration efforts to provide complementary protection for the barrier islands, it would extend to providing protection to inland cultural resources.

5.12.1.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.12.1.5.1 Direct

Direct impacts of implementing Alternative 3 would be a combination of those described for Alternative 11 and Alternative 2, with the addition of use of the Raccoon Island Restoration Borrow Area 5.

The Raccoon Island Restoration Borrow Area 5 has been investigated, and targets representing potentially significant cultural resources will be avoided. The borrow area limits and avoidance areas are included in Appendix L. There will be no direct impacts to historic properties if the targets representing potential historic properties are avoided

5.12.1.5.2 Indirect

Indirect impacts of implementing Alternative 3 would be a combination of those described for Alternative 11 and Alternative 2.

5.12.1.5.3 Cumulative

Cumulative impacts of implementing Alternative 3 would be a combination of those described for Alternative 11 and Alternative 2.

5.12.1.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.12.1.6.1 Direct

The direct impacts of implementing Alternative 4 would include those described for Alternative 11, Alternative 2, and Alternative 3, with the addition of the Trinity Island APE and the and New Cut Borrow Area 4.

There is a low probability for significant prehistoric archaeological sites or prehistoric watercraft, historic archaeological sites or standing structures within the Trinity Island APE. The Trinity Island APE was largely subaerially exposed until the mid-twentieth century and is considered to have low probability for historic shipwrecks. No historic properties have been identified in the Trinity Island APE; therefore, no direct impacts to historic properties are anticipated.

The New Cut Borrow Area 4 has been investigated, and targets representing potentially significant cultural resources will be avoided. The borrow area limits and avoidance areas are included in Appendix L. There will be no direct impacts to historic properties if the targets representing potential historic properties are avoided.

5.12.1.6.2 Indirect

Indirect impacts of implementing Alternative 4 would be a combination of those described for Alternative 3 and the above-referenced minimal impacts from the Trinity Island APE and the New Cut Borrow Area 4.

5.12.1.6.3 Cumulative

Cumulative impacts of implementing Alternative 4 would be a combination of those described for Alternative 3, the above-referenced minimal impacts from the Trinity Island APE, the New Cut Borrow Area 4, and the long-term protection for any cultural resources afforded by the protection resulting from Trinity Island renourishment at TY25. This protection should last through the 50-year period of analysis for the Study. As with Alternative 11, should there be other Federal, State, local, and private restoration efforts to provide complementary protection for the barrier islands, it would extend to providing protection to inland cultural resources.

5.13 AESTHETICS

5.13.1.1 No Action Alternative (Future without Project Conditions)

5.13.1.1.1 Direct

The visual complexity surrounding the Study Area is related to its geomorphic structures including beach, dune, and marsh. All of these elements are critical systems inclusive to the Terrebonne Basin Barrier Shoreline System. Together, all of these elements provide a pleasing aesthetic view shed to the public.

5.13.1.1.2 Indirect

Without implementation of the barrier restoration features, existing conditions will persist resulting in the continued loss and degradation of the barrier islands. Degradation of the barrier islands would convert existing views of beach, dune, and wetland to more open water views.

5.13.1.1.3 Cumulative

Cumulative impacts would be the synergistic effect of the No-Action Alternative on aesthetic resources with the additive combination of similar impacts from wetland loss and degradation throughout coastal Louisiana, as well as the benefits and impacts of other State and Federal projects in the vicinity.

5.13.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.13.1.2.1 Direct

Viewscapes would be disturbed by construction activities and the use of rock as a shoreline protection structure. There may be some perceived visual disturbance as an unnatural terminal groin structure is placed at the end of Raccoon Island. Even though the shoreline protection features would remain visually disruptive, the visual benefits surrounding the protection of visually complex wetlands viewscapes would outweigh the slight negative impact on aesthetics.

With the implementation of any shoreline protection feature, the viewscapes around the Study Area would experience limited short-term disruption imposed by the working activities of the floating dredge plant. These minor impacts would be localized and temporary. The Study Area should quickly stabilize, and the newly created, nourished and protected emergent wetlands would provide new high quality viewscapes as well as protect existing ones.

5.13.1.2.2 Indirect

Indirect impacts to visual resources would primarily result from newly created high quality emergent wetland viewscapes that would provide a long-term visual enhancement of an area that is presently experiencing a decline in visual complexity.

5.13.1.2.3 Cumulative

Cumulative impacts would be the synergistic effect with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, State, local, and private restoration efforts. Alternative 11 would work synergistically with those projects to provide more complete protection for the barrier islands, which would increase the quality of the visually complex viewscapes throughout the Study Area. Cumulative impacts of maintaining appealing viewscapes would also support eco-tourism as one travels Louisiana's Scenic Byways and remote areas of visual interest.

5.13.1.3 Alternative 11: Whiskey (Plan C)

5.13.1.3.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan).

5.13.1.3.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan).

5.13.1.3.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan).

Alternative 2: Timbalier (Plan E)

5.13.1.3.4 Direct

Direct impacts would be similar to Alternative 5 (NER Plan).

5.13.1.3.5 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan).

5.13.1.3.6 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan)

5.13.1.4 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.13.1.4.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan).

5.13.1.4.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan).

5.13.1.4.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan).

5.13.1.5 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.13.1.5.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan).

5.13.1.5.2 Indirect

Indirect impacts are similar to Alternative 5 (NER Plan).

5.13.1.5.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan).

5.14 Recreation

As described in Section 4.2.14, above, the primary recreational activities on the Terrebonne Basin Barrier Islands and their adjacent marshes and surface waters are hunting and fishing. With the exception of mainland shoreline-based waterfowl hunting and wading-depth fishing, watercraft are necessary to undertake recreational activities on the marshes, islands, and in open water of the Terrebonne Basin. All of these recreational activities provide business for charter fishermen, private marinas and boat launching facilities, and local supply and service companies (USFWS, 2003).

The Terrebonne Basin is a hot spot for fishing and boating activities in coastal Louisiana, primarily because the uninhabited barrier islands (including their associated marshes) still provide protective and productive habitats for a range of fisheries resources. While many anglers visit the Terrebonne Basin with their own boats, and utilize boat launching sites, there is a large population who own, co-own, or rent houses and fishing camps located on the bayou and canal shorelines. The concentrations of these are centered along the Houma Navigation Canal, in the vicinity of Dulac, along Bayou Petite Caillou, approaching Cocodrie, and along Bayou Lafouche, approaching Port Fourchon. Cocodrie itself has more fishing camps and marinas than any other urban area in coastal Louisiana. Table 5-9 presents data for facilities in the vicinity of Cocodrie and Holly Beach, on the Gulf in Cameron Parish. Both communities are centers of recreational activity.

Table 5-9: Facilities in the Vicinity of Cocodrie

Location	Marinas/Charter Docks	Houses/Camps	Nearest City
Cocodrie, LA	7	>400	Houma – 31 miles N
Holly Beach, LA	2	>150	Cameron – 10 miles E

5.14.1.1 No Action Alternative (Future without Project Conditions)

5.14.1.1.1 Direct

The No Action Alternative, not implementing barrier island restoration features, would have no direct impacts on oyster leases recreation resources. Existing conditions would persist. Much of the recreational activity occurring in Louisiana consists of hunting, fishing, and wildlife viewing and photography. Recreational resources in the Louisiana coastal zone that would be most affected in the Future Without-Project conditions are those related to loss of wetlands/marshes and habitat diversity. The general trend in wildlife abundance has been a decrease in wildlife numbers in areas experiencing high land loss and an increase in areas of freshwater input or land building due to restoration projects. Populations of migratory birds and other animals directly dependent on the marsh and swamp would decrease dramatically, an impact which would be felt in much of North America, where many of these migratory species spend parts of their life cycles. With the continued conversion of marsh to open water, much of the fishery productivity would be expected to peak followed by a sharp decline.

5.14.1.1.2 Indirect

The coastal zone's changing environment would affect the recreational resources within that area. As existing barrier islands are lost and freshwater wetland/marsh areas transition to saltwater marsh, and subsequently to open water, the recreational opportunities would change accordingly: in part from actual habitat shift and in part from loss of the nursery functions provided by that habitat. As populations of freshwater and/or saltwater species decline, so would fishing opportunities (including crawfishing, crabbing, oyster harvesting, and recreational shrimping). In transitional and upland areas where populations of game species exist, hunting opportunities would be reduced as the landscape became less supportive of those species. The same holds true for the populations of migratory waterfowl and other bird species, which will affect opportunities for viewing.

Another major impact of barrier island land loss, and land loss in general, is the possible loss of facilities and infrastructure that support or are supported by recreational activities. Land loss can literally result in the loss of boat launches, parking areas, access roads, marinas, and supply shops. The loss of access features, such as roads and boat launches, directly impacts an individual's ability to recreate in particular areas. The economic loss felt by marinas and other recreational service and supply providers may be two-fold. One is potential loss of the actual facility or access to the facility; the other is change in opportunities. Habitat change and resulting changing recreation opportunities (i.e., fresh water to marine) may for example severely impact a marina specializing in services for particular types of recreation (i.e., a shift from freshwater to estuarine and offshore fishing might necessitate changes in boat slip dimensions, deepening of basins, and access channels to accommodate a different mix of recreational vessels).

5.14.1.1.3 Cumulative

Without action, the recreation needs identified by the SCORP for the Terrebonne Basin in general, and the Study Area in particular, will increase. Land loss in general, particularly the gradual loss of the barrier islands, coupled with conversion of marsh to open water, will undoubtedly be the largest impact to recreation resources. Over time, conversion of marsh to open water will result in a decline of estuary-dependent recreation. Access to marsh-based recreation opportunities, another identified need, will also be impacted by predicted land loss.

5.14.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.14.1.2.1 Direct

The immediate direct recreational resources impact from implementation of the NER Plan would be temporary closure of each island's Study Area during construction. In addition, there will be a temporary decrease in the quality of recreational opportunities as the wetland restoration sites are allowed to settle, vegetation is restored, and tidal circulation is reestablished naturally. The recreational benefits and opportunities will rebound as the restored marshes take root. It is important to understand that both Raccoon and Whiskey Islands are part of the Terrebonne Barrier Islands Refuge, managed by the Louisiana Department of Wildlife and Fisheries, which is closed to the public. The surrounding waters are available for recreation, but trespass on the islands themselves is prohibited. As formulated, the plan involves filling several canals on both Trinity and Timbalier Islands. These canals were excavated and have been maintained to provide access to oil or gas wells, and continued service/maintenance access will have to be accommodated in cooperation with the well owners. The canals are periodically used as mooring areas for houseboats and their elimination will have a negative impact on that form of recreation.

5.14.1.2.2 Indirect

Alternative 5 (NER Plan) will protect, create and nourish transitional estuarine wetlands. Following construction, these transitional estuarine wetlands will provide important and essential fish and wildlife habitats that will contribute to restoring and nurturing the food chain for the organisms that provide the base for recreational activities such as fishing, wildlife viewing, and camping. Increased opportunity for recreational activities will come from expansion of new vegetative habitat on newly created areas and the protection from storm-related stressors that the restored beach, dune, and marsh areas will afford adjacent existing habitats.

5.14.1.2.3 Cumulative

The cumulative impacts from implementing the NER Plan would be provision of the above-referenced recreational benefits into the future, assuming that the proposed renourishment events are undertaken. Should other Federal, State, local, and private restoration efforts be forthcoming, they will provide an additive combination of impacts and benefits for overall net acres created, nourished, and protected. Alternative 5 (NER Plan) will work synergistically with those projects to provide more complete protection for barrier islands, which will continue to provide wetland-dependent recreational opportunities in the Study Area.

5.14.1.3 Alternative 11: Whiskey (Plan C)

5.14.1.3.1 Direct

The primary direct impact on recreational resources will result from the Study Area being temporarily unavailable during construction. In addition, there will be a temporary decrease in the quality of recreational opportunities as the wetland restoration sites are allowed to settle, vegetation is restored, and tidal circulation is reestablished naturally. The recreational benefits and opportunities will rebound as the restored marshes take root.

5.14.1.3.2 Indirect

Alternative 11 will protect, create and nourish a transitional estuarine wetland on a single island. Following construction, this transitional estuarine wetland will provide important and essential fish and wildlife habitat that will contribute to restoring and nurturing the food chain for the organisms that provide the base for recreational activities such as fishing and wildlife viewing. Increased recreation activity will come from expansion of new vegetative habitat on newly created areas and the protection from storm-related stressors that the restored beach, dune, and marsh areas will afford adjacent existing habitats.

5.14.1.3.3 Cumulative

The cumulative impacts from implementing the first component of construction plan would be provision of the above-referenced recreational benefits into the future, assuming that the proposed renourishment events are undertaken. Should other Federal, State, local, and private restoration efforts be forthcoming, they will provide an additive combination of impacts and benefits for overall net acres created, nourished, and protected. Alternative 11 will work synergistically with those projects to provide more complete protection for barrier islands, which will continue to provide wetland-dependent recreational opportunities in the Study Area.

5.14.1.4 Alternative 2: Timbalier (Plan E)

5.14.1.4.1 Direct

Direct impacts would be similar to Alternative 11, with recreational activity curtailed during construction, and rebounding of both benefits and opportunities following restoration and vegetation reestablishment.

5.14.1.4.2 Indirect

Indirect impacts would be similar to Alternative 11 because this too is a single island effort. However, because Timbalier Island is not part of the Terrebonne Barrier Island Reserve, camping and land-based recreation are not prohibited, and would benefit from the habitat improvement.

5.14.1.4.3 Cumulative

Cumulative impacts would be similar to Alternative 11, assuming that the proposed renourishment event occurs at TY30.

5.14.1.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.14.1.5.1 Direct

Direct impacts would be less than those for Alternative 5 (NER Plan), because this alternative only involves two of the four islands.

5.14.1.5.2 Indirect

As with the direct impacts, the indirect impacts would be the same as for Alternative 5 (NER Plan), but of a reduced magnitude and scope because they only involve two islands.

5.14.1.5.3 Cumulative

The cumulative impacts would be the same as for Alternative 5 (NER Plan), but of a reduced magnitude and scope because they are only derived from two islands.

5.14.1.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.14.1.6.1 Direct

Direct impacts would be a reduction of those for Alternative 5 (NER Plan) because the alternative only derives benefits from restoration of three of the four islands. However, because neither Trinity nor Timbalier Islands are included in the Reserve, both camping and land-based recreation will be available after completion of construction.

5.14.1.6.2 Indirect

As with the direct impacts the indirect impacts would be similar to Alternative 5 (NER Plan), but reduced because they are derived from three islands, while the NER Plan is for four islands.

5.14.1.6.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan) but somewhat reduced because the benefits derived from restoration of Raccoon Island will be missing. Because Whiskey Island will be renourished in TY20 and TY40, and the others in TY25 and TY30, there will be localized disruption due to construction throughout the 50-year planning period. The overall benefits from restoring the barrier island habitats obviously outweigh the limited disturbance.

5.15 Socioeconomics and Human Resources

5.15.1 Population and Housing

5.15.1.1 No Action Alternative (Future without Project Conditions)

The Study area is uninhabited and inaccessible, except by boat or aircraft. Five of the islands (Raccoon, Whiskey, Trinity/East and Wine) make up the Isles Dernieres Barrier Islands Refuge (IDBIR) which is managed by the LDWF. Access to the IDBIR is regulated by the LDWF. As referenced in the previous section, there are transient campers, often based from houseboats, and a few “camp” type structures on Timbalier and East Timbalier Islands. In addition, there are several petroleum transmission and processing facilities on or north of the latter two islands that appear to have crew accommodations

5.15.1.1.1 Direct

The No Action Alternative for population and housing would have no direct impacts on human populations. Not implementing wetland creation/ nourishment and shoreline protection features would result in the persistence of existing conditions. The Study Area is a remote and uninhabited marsh and there are no human populations and/or housing are within the Study Area.

5.15.1.1.2 Indirect

There is no population residing within the Study Area, and the proposed action would have no indirect impacts outside the Study Area.

5.15.1.1.3 Cumulative

The cumulative impact of no further action would lead to continuing erosion of the barrier islands and their associated wetland and marsh habitats. Left unchecked, the loss of wetland and marsh would continue progressing north in the Terrebonne Basin to the point where it could diminish protection for inhabited areas, such as Cocodrie and Port Fourchon, as well as for the numerous petroleum transmission and processing facilities scattered across Terrebonne and Timbalier Bays and their marshes.

5.15.1.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.1.2.1 Direct

The direct impacts would be the same as the No Action Alternative

5.15.1.2.2 Indirect

The indirect impacts would be the same as the No Action Alternative

5.15.1.2.3 Cumulative

The cumulative impact of implementing the NER Plan would be to retard the erosion of the islands and their associated wetlands and marshes, thus reducing the potential for land loss to the north. Should other Federal, State, local, and private restoration efforts be forthcoming, they will provide an additive combination of impacts and benefits for overall net acres created, nourished, and protected. Alternative 5 (NER Plan) will work synergistically with those projects to provide more complete protection for the barrier islands and the inhabited areas to the north in the Terrebonne Basin.

5.15.1.3 Alternative 11: Whiskey (Plan C)

5.15.1.3.1 Direct

There is no population residing within the Study Area, and the proposed action would have no direct impacts outside the Study Area.

5.15.1.3.2 Indirect

There is no population residing within the Study Area, and the proposed action would have no indirect impacts outside the Study Area.

5.15.1.3.3 Cumulative

The cumulative effect of restoration of a single barrier island will be minimal. The protection a restored Whiskey Island affords the immediately adjacent wetlands, which are also uninhabited, will have no impact on population or housing. Should other Federal, State, local, and private restoration efforts be forthcoming in the Terrebonne Basin, they will provide an additive combination of impacts and benefits for overall net acres created, nourished, and protected. Alternative 11 will work synergistically with those projects to provide more complete protection for the barrier islands and the inhabited areas to the north in the Terrebonne Basin.

5.15.1.4 Alternative 2: Timbalier (Plan E)

5.15.1.4.1 Direct

Direct impacts would be similar to the Timbalier component of Alternative 5 (NER Plan).

5.15.1.4.2 Indirect

Indirect impacts would be similar to the Timbalier component Alternative 5 (NER Plan).

5.15.1.4.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan), but to a lesser extent.

5.15.1.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.1.5.1 Direct

Direct impacts would be similar to the Whiskey/Timbalier Island components of Alternative 5 (NER Plan).

5.15.1.5.2 Indirect

Indirect impacts would be similar to the Whiskey/Timbalier Island components of Alternative 5 (NER Plan).

5.15.1.5.3 Cumulative

Cumulative impacts would be similar to the Whiskey/Timbalier Islands component of Alternative 5 (NER Plan), but of a reduced magnitude and scope because they are only derived from two islands.

5.15.1.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.1.6.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan) without Raccoon Island.

5.15.1.6.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan) without Raccoon Island.

5.15.1.6.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan) without Raccoon Island.

5.15.2 Employment and Income

5.15.2.1 No Action Alternative (Future without Project Conditions)

The Study area is uninhabited and inaccessible, except by boat or aircraft. Five of the islands (Raccoon, Whiskey, Trinity/East and Wine) make up the Isles Dernieres Barrier Islands Refuge (IDBIR) which is managed by the LDWF. Access to the IDBIR is regulated by the LDWF. Regarding employment and income, there are no businesses or other employment opportunities on the barrier islands. As referenced in the previous section, there are several petroleum transmission and processing facilities on or north of Timbalier and East Timbalier Islands that appear to have crew accommodations and there are other, less elaborate facilities scattered behind and between the islands that obviously require routine servicing/maintenance, but those activities appear to be based from mainland communities, such as Cocodrie and Port Fourchon. Extensive commercial fishing, guided recreational fishing, and ecotourism are undertaken in the Terrebonne Basin and around the barrier islands. Like the aforementioned service/maintenance activities, these, too, are based from mainland communities, notably Cocodrie and Dulac.

5.15.2.1.1 Direct

The No Action Alternative, not implementing the barrier restoration features, would have no direct impacts on employment or income.

5.15.2.1.2 Indirect

Indirect impacts would result in the persistence of existing conditions including continued wetland loss and degradation of the barrier islands and coastal wetlands north of the Study Area. This continued wetland loss would have some localized impacts on employment and income if it resulted in abandonment or relocation of oil and gas distribution/processing facilities.

5.15.2.1.3 Cumulative

The impacts of wetland loss and degradation of the barrier islands will lead to a decline in transitional wetland habitats, an important EFH which, in turn, could lead to some undetermined level of economic decline in local fishery-related employment and income. The aforementioned impact on oil and gas distribution/ processing facilities could extend north into the Terrebonne Basin, as the remaining Basin wetlands deteriorate.

5.15.2.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.2.2.1 Direct

Direct impacts would be similar to the No Action Alternative, as there are no businesses or employment opportunities on the four islands.

5.15.2.2.2 Indirect

Alternative 5 (NER Plan) will protect, create and nourish transitional estuarine wetlands. Following construction, these transitional estuarine wetlands will provide important and essential fish and wildlife habitats that will contribute to restoring and nurturing the food chain for the organisms that provide the base for commercial and recreational activities such as fishing and ecotourism. Restored and protected wetlands could obviate the need for abandonment or relocation of otherwise vulnerable oil and gas facilities, and the employment opportunities that accompany them.

5.15.2.2.3 Cumulative

The cumulative impacts from implementing the NER Plan would be provision of the above-referenced employment and income benefits into the future, assuming that the proposed renourishment events are undertaken. Should other Federal, State, local, and private restoration efforts be forthcoming, they will provide an additive combination of impacts and benefits for overall net acres created, nourished, and protected. Alternative 5 (NER Plan) will work synergistically with those projects to provide more complete protection for barrier islands, which will continue to provide wetland-dependent employment opportunities in the Study Area.

5.15.2.3 Alternative 11: Whiskey (Plan C)

5.15.2.3.1 Direct

As part of the aforementioned wildlife refuge, trespass on Whiskey Island is prohibited. Restoration of this single island will have no direct impact on employment and income, as there are no businesses or employment opportunities on the island. Commercial and recreational fishing will be temporarily curtailed during construction in the Study Area These activities can resume after construction is completed. The creation of a transitional estuarine wetland on the island will provide important and essential fish and wildlife habitat that will contribute to restoring and nurturing the food chain for the organisms that provide the base for commercial and recreational activities, such as fishing and ecotourism (wildlife viewing, *etc.*), thus facilitating income generation. Implementing this alternative could result in turbidity or fill impacts on several oyster leases near the Study Area

5.15.2.3.2 Indirect

Implementing this single island alternative would provide limited benefits to commercial and recreational fisheries by increasing the quantity and quality of essential fish habitat available for nursery and other aquatic life functions. In addition this alternative provides some protection of adjacent oyster leases from being directly exposed to the higher saline waters of the Gulf.

5.15.2.3.3 Cumulative

The cumulative impact of Whiskey Island restoration will be protection afforded the adjacent marsh and upland areas, thus facilitating productivity of fisheries resource, including oysters. With the anticipated renourishment events at TY20 and TY40 such protection would last through the 50-year period of analysis. Should there be other Federal, State, local, and private restoration efforts to provide complementary protection for the barrier islands and the fishery resources they nurture.

5.15.2.4 Alternative 2: Timbalier (Plan E)

5.15.2.4.1 Direct

Even though Timbalier Island is not within the Terrebonne Barrier Islands Refuge, the direct impacts would be similar to Alternative 11. The restoration and subsequent renourishment in TY30 would protect the oil and gas transmission and processing infrastructure located behind the island, which continues to provide employment opportunities. Should those facilities be abandoned or relocated, those opportunities would be eliminated.

5.15.2.4.2 Indirect

As above, the indirect impacts of restoration of a single island would be similar to Alternative 11 and to the aforementioned directs impacts.

5.15.2.4.3 Cumulative

The cumulative impacts would be similar to those from Alternative 11), however there is only one renourishment event, planned for TY30. In addition, the aforementioned petroleum infrastructure protection would persist through the 50-year planning period for the project.

5.15.2.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.2.5.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan), but reduced in scale because this alternative only involves restoration of two islands.

5.15.2.5.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan), but reduced in scale because this alternative only involves restoration of two islands.

5.15.2.5.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan), but reduced in scale because this alternative only involves restoration of two islands.

5.15.2.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.2.6.1 Direct

The direct impacts would be similar to Alternative 5 (NER Plan), but reduced in scale because this alternative only involves restoration of three islands. As with Alternatives 2 and 3, the petroleum infrastructure located at Timbalier Islands would be afforded protection, which translates into continued employment for service technicians and other workers.

5.15.2.6.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan), but reduced in scale because this alternative only involves restoration of three islands.

5.15.2.6.3 Cumulative

C Cumulative impacts would be similar to Alternative 5 (NER Plan), but reduced in scale because this alternative only involves restoration of three islands.

5.15.3 Community Cohesion

5.15.3.1 No Action Alternative (Future without Project Conditions)

The No Action Alternative would have no direct impacts on community cohesion. Not implementing wetland creation/nourishment and shoreline protection features would result in the persistence of existing conditions. The Study Area is remote and uninhabited barrier islands, with no communities or permanent population.

5.15.3.1.1 Indirect

The No Action Alternative would have no indirect impact on community cohesion because the Study Area is uninhabited.

5.15.3.1.2 Cumulative

The No Action Alternative may have cumulative impacts on community cohesion if the islands continue to erode to the point where the interior wetlands cease to protect the upland communities. If the communities are jeopardized by increasingly frequent tidal inundation and storm surge impacts abandoning them may be more cost-effective than constructing and maintaining levees or other barriers. In addition, conversion of Terrebonne Bay to an open water habitat, with loss of the marshes and estuarine environment, will have detrimental impacts on a range of fisheries and wildlife resources as well as the petroleum infrastructure that exists throughout the basin, resulting in a detrimental impact to the communities dependent on those resources.

5.15.3.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.3.2.1 Direct

Since there are no communities on the barrier islands, implementation of Alternative 5 will have no direct impact on community cohesion.

5.15.3.2.2 Indirect

Since there are no communities on the barrier islands, implementation of Alternative 5 will have no indirect impact on community cohesion.

5.15.3.2.3 Cumulative

The cumulative impact of the NER Plan on community cohesion would be positive. By slowing wetland loss and retaining the protective function of the barrier islands communities dependent on the basin resources would be less likely to lose cohesion and community identity.

5.15.3.3 Alternative 11: Whiskey (Plan C)

5.15.3.3.1 Direct

There is no community residing within the Study Area, and the proposed action would have no direct impacts outside the Study Area.

5.15.3.3.2 Indirect

There is no community residing within the Study Area, and the proposed action would have no indirect impacts outside the Study Area.

5.15.3.3.3 Cumulative

There is no community residing within the Study Area, and the proposed action would have no cumulative impacts outside the Study Area.

5.15.3.4 Alternative 2: Timbalier (Plan E)

5.15.3.4.1 Direct

Direct impacts would be similar to Alternative 11.

5.15.3.4.2 Indirect

Indirect impacts would be similar to Alternative 11.

5.15.3.4.3 Cumulative

The restoration and renourishment of Timbalier Island at TY30 will continue to afford protection to the petroleum transmission and processing facilities behind the island, which will have a positive impact on community cohesion.

5.15.3.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.3.5.1 Direct

Since there are no communities on the barrier islands, implementation of Alternative 3 will have no direct impact on community cohesion.

5.15.3.5.2 Indirect

Since there are no communities on the barrier islands, implementation of Alternative 3 will have no indirect impact on community cohesion.

5.15.3.5.3 Cumulative

Cumulative impacts would be similar to Alternative 2.

5.15.3.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.3.6.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan), but of reduced scope, since it only involves three islands.

5.15.3.6.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan), but of reduced scope, since it only involves three islands.

5.15.3.6.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan), but of reduced scope, since it only involves three islands.

5.15.4 Environmental Justice

5.15.4.1 No Action Alternative (Future without Project Conditions)

5.15.4.1.1 Direct

There would be no direct impact of the No Action Alternative on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.1.2 Indirect

There would be no indirect impact of the No Action Alternative on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.1.3 Cumulative

There would be no cumulative impact of the No Action Alternative on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.4.2.1 Direct

There would be no direct impact of Alternative 5 (NER Plan) on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.2.2 Indirect

There would be no indirect impact of Alternative 5 (NER Plan) on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.2.3 Cumulative

There would be no cumulative impact of Alternative5 (NER Plan) on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited).

5.15.4.3 Alternative 11: Whiskey (Plan C)

5.15.4.3.1 Direct

There would be no direct impact of Alternative 11 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.3.2 Indirect

There would be no indirect impact of Alternative 11 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.3.3 Cumulative

There would be no cumulative impact of Alternative 11 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.4 Alternative 2: Timbalier (Plan E)

5.15.4.4.1 Direct

There would be no direct impact of Alternative 2 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.4.2 Indirect

There would be no indirect impact of Alternative 2 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.4.3 Cumulative

There would be no cumulative impact of Alternative 2 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.4.5.1 Direct

There would be no direct impact of Alternative 3 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.5.2 Indirect

There would be no indirect impact of Alternative 3 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.5.3 Cumulative

There would be no cumulative impact of Alternative 3 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.4.6.1 Direct

There would be no direct impact of Alternative 4 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.6.2 Indirect

There would be no indirect impact of Alternative 4 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.4.6.3 Cumulative

There would be no cumulative impact of Alternative 4 on environmental justice, as this concept is inapplicable within the Study Area. The Study Area is undeveloped and uninhabited.

5.15.5 Infrastructure

The Terrebonne Basin Barrier Islands have no public infrastructure, such as streets, potable water supply and distribution, and wastewater collection and treatment. The islands are uninhabited and undeveloped and inaccessible except by boat or aircraft. Private infrastructure exists throughout the Terrebonne Basin in the form of oil and gas wells, transmission lines, and petroleum distribution, storage, and processing facilities

5.15.5.1 No Action Alternative (Future without Project Conditions)

5.15.5.1.1 Direct

The Study Area is remote and uninhabited. The existing private infrastructure includes oil and gas pipelines; storage tank batteries, platforms, and wellheads. The effects of continued barrier island loss and degradation will lead to increased costs for maintenance and repair of the existing infrastructure, reduced level of oil and gas infrastructure development, and possible relocation of some existing oil and gas assets.

5.15.5.1.2 Indirect

The indirect impacts of the No Action Alternative will be the same as the direct impacts, because the private infrastructure is scattered throughout the Terrebonne Basin in open water and on other islands and remaining marsh areas. As the barrier islands disappear these areas will become increasingly vulnerable, resulting in the same impacts.

5.15.5.1.3 Cumulative

The cumulative impact will be the same as the direct and indirect as the basin's islands and wetlands deteriorate and shift to open water.

5.15.5.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.5.2.1 Direct

Implementing the NER Plan would provide protection to the private infrastructure on and adjacent to the four islands. Due to the planned renourishment events, this protection should last for the duration of the 50-year period of analysis.

5.15.5.2.2 Indirect

Indirect impacts would be similar to the direct impacts of Alternative 5 (NER) but expanded to the infrastructure located to the north in open water and on the other islands in Terrebonne Bay.

5.15.5.2.3 Cumulative

Cumulative impacts would be similar to the indirect impacts, as long as the proposed renourishment events are undertaken.

5.15.5.3 Alternative 11: Whiskey (Plan C)

5.15.5.3.1 Direct

Implementing this single island alternative would provide protection to the existing infrastructure in the immediate area of Whiskey Island, assuming the proposed renourishment events are undertaken in TY20 and TY40. Appropriate safety precautions will be implemented for this and all other alternatives to avoid potential construction-related impacts to existing infrastructure (*e.g.*, pipelines, wellheads, *etc.*).

5.15.5.3.2 Indirect

Implementing this single island alternative would have no indirect impacts on existing infrastructure beyond the immediate area of Whiskey Island.

5.15.5.3.3 Cumulative

Implementing this single island alternative would have no cumulative impacts on existing infrastructure beyond the immediate area of Whiskey Island.

5.15.5.4 Alternative 2: Timbalier (Plan E)

5.15.5.4.1 Direct

Implementing this single island alternative would provide protection to the extensive existing infrastructure in the immediate area of Timbalier Island, assuming the renourishment event is undertaken in TY30. Appropriate safety precautions will be implemented for this and all other alternatives to avoid potential construction-related impacts to existing infrastructure (e.g., pipelines, wellheads, etc.).

5.15.5.4.2 Indirect

Implementing this single island alternative would have no indirect impacts on existing infrastructure beyond the immediate area of Timbalier Island.

5.15.5.4.3 Cumulative

Implementing this single island alternative would have no cumulative impacts on existing infrastructure beyond the immediate area of Timbalier Island.

5.15.5.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.5.5.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan) but of lesser benefit because Alternative 3 only involves two islands, however, as pointed out above, Timbalier Island has extensive oil and gas industry infrastructure that would be protected

5.15.5.5.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan), but of lesser benefit because Alternative 3 only involves two islands.

5.15.5.5.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan), but of lesser benefit because Alternative 3 only involves two islands.

5.15.5.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.5.6.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan) but of lesser benefit because Alternative 4 only involves three islands, however, as pointed out above, Timbalier Island has extensive oil and gas industry infrastructure that would be protected.

5.15.5.6.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan), but of somewhat lesser benefit because Alternative 4 only involves three islands.

5.15.5.6.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan), but of somewhat lesser benefit because Alternative 4 only involves three islands. As mentioned previously, the cumulative benefits will only be realized if the proposed renourishment events occur in the target years indicated.

5.15.6 Business and Industry

5.15.6.1 No Action Alternative (Future without Project Conditions)

5.15.6.1.1 Direct

The Study Area is remote and uninhabited. The primary industry in the Study Area involves oil and gas extraction, processing, and transmission. Also of considerable economic importance in the Terrebonne Basin are the commercial fisheries for shrimp, finfish, and oysters. The effects of continued barrier island loss and degradation will lead to increased maintenance costs for existing oil and gas infrastructure, reduced level of oil and gas infrastructure development, and relocation of some existing oil and gas assets. The no-action alternative would not have any immediate direct impact on commercial fisheries. Existing conditions will persist. The continued loss of wetland habitat within the Study Area and the Terrebonne Basin, combined with the ongoing widespread wetland loss throughout coastal Louisiana, will contribute to an overall decrease in productivity of Louisiana's coastal fisheries. The target species for the fisheries are estuary-dependent species. As the estuaries and the marshes diminish in area and productivity, their ability to provide shelter and forage for those species also diminishes.

5.15.6.1.2 Indirect

The indirect impacts of the No Action Alternative will be the same as the direct impacts, because the industrial infrastructure is scattered throughout the Terrebonne Basin in open water and on other islands and remaining marsh areas. As the barrier islands disappear these areas will become increasingly vulnerable, resulting in the same impacts. The indirect impact to the commercial fishery businesses will result from the gradual decline in abundance of the target resources which will require adjustment to other target species or relocation to other more productive fishing grounds. This adjustment could be unavoidable, if the regulatory agencies conclude that the resources have exceeded their maximum sustainable yield and close the fishery.

5.15.6.1.3 Cumulative

The cumulative impacts of the No Action Alternative will be the same as the indirect impacts, because the industrial infrastructure is scattered throughout the Terrebonne Basin in open water and on other islands and remaining marsh areas. As the barrier islands disappear these areas will become increasingly vulnerable, resulting in the same impacts. Cumulative impacts to commercial fisheries in the Study Area will be the same as the indirect impacts.

5.15.6.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.6.2.1 Direct

The direct impacts of implementing the NER Plan will provide protection to the industrial infrastructure on and adjacent to the four islands. Due to the planned renourishment events, this protection should last for the duration of the 50-year period of analysis. Restoration of the barrier islands and their associated marshes will slow the deterioration of the interior wetlands by affording them protection against direct storm damage. In addition the restored marshes will continue to provide the shelter and nursery functions required by the estuary-dependent fishery resources.

5.15.6.2.2 Indirect

The indirect impacts will be similar to the direct impacts because the industrial infrastructure is scattered throughout the Terrebonne Basin, as are the fishery resources and the marshes and other wetlands upon which they depend for shelter and forage.

5.15.6.2.3 Cumulative

The cumulative impacts will be similar to the direct and indirect impacts.

5.15.6.3 Alternative 11: Whiskey (Plan C)

5.15.6.3.1 Direct

Whiskey Island does not protect any industrial infrastructure, so the direct impact of its restoration will be negligible. However, restoration of the marsh and its protective beach and dune will provide a benefit to the fishery resources similar to Alternative 5 (NER Plan), but at a reduced scale.

5.15.6.3.2 Indirect

The indirect impacts of implementing Alternative 11 will be similar to the direct impacts.

5.15.6.3.3 Cumulative

The cumulative impacts of implementing Alternative 11 will be similar to the direct impacts.

5.15.6.4 Alternative 2: Timbalier (Plan E)

5.15.6.4.1 Direct

The direct impacts of implementing Alternative 2 would be similar to Alternative 11. In addition, Timbalier Island protects a significant amount of industrial infrastructure from direct impact from the Gulf of Mexico and, similarly to Whiskey Island, the restored marsh and its protective beach and dune will provide a benefit to fishery resources, due to the proposed renourishment at TY30.

5.15.6.4.2 Indirect

As a single island restoration, the indirect impacts would be similar to the direct impacts.

5.15.6.4.3 Cumulative

The cumulative impacts would be similar to the direct and indirect impacts, providing localized benefits to industrial infrastructure and fisheries resources, but minimal far-field benefits.

5.15.6.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.6.5.1 Direct

The direct impacts would be similar to Alternative 5 (NER Plan) but of lesser benefit because Alternative 3 only involves two islands. However, as pointed out above, Timbalier Island has extensive industrial infrastructure that would be protected.

5.15.6.5.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan), but of lesser benefit because Alternative 3 only involves two islands. Assuming the proposed renourishment of Whiskey Island at TY20 and TY40, plus the renourishment of Timbalier Island at TY30, the restored beach, dune, and marsh components on each island will provide benefit to the fishery resources in the vicinity of both islands.

5.15.6.5.3 Cumulative

The cumulative impacts would be similar to the direct and indirect impacts, providing localized benefits to industrial infrastructure and fisheries resources, but minimal far-field benefits.

5.15.6.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.6.6.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan), but somewhat reduced because they will be derived from only three islands.

5.15.6.6.2 Indirect

Indirect impacts would be similar to the direct benefits.

5.15.6.6.3 Cumulative

Cumulative impacts would be similar to the direct and indirect benefits.

5.15.7 Traffic and Transportation

5.15.7.1 No Action Alternative (Future without Project Conditions)

5.15.7.1.1 Direct

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by shoal-draft boat or aircraft. There is no public or private transportation infrastructure. There would be no direct impacts of the No Action on traffic and transportation, as this feature does not exist within the Study Area

5.15.7.1.2 Indirect

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by shoal-draft boat or aircraft. There is no public or private transportation infrastructure. There would be no indirect impacts of the No Action Alternative on traffic and transportation, as this feature does not exist within the Study Area

5.15.7.1.3 Cumulative

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by shoal-draft boat or aircraft. There is no public or private transportation infrastructure. There would be no cumulative impacts of the No Action Alternative on traffic and transportation, as this feature does not exist within the Study Area

5.15.7.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.7.2.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.7.2.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.7.2.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.7.3 Alternative 11: Whiskey (Plan C)

5.15.7.3.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.7.3.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.7.3.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.7.4 Alternative 2: Timbalier (Plan E)

5.15.7.4.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.7.4.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.7.4.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.7.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.7.5.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.7.5.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.7.5.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.7.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.7.6.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.7.6.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.7.6.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.8 Public Facilities and Services

5.15.8.1 No Action Alternative (Future without Project Conditions)

5.15.8.1.1 Direct

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by boat or aircraft. There are no public facilities or public services on the islands. There would be no direct impacts of the No Action Alternative on public facilities and services, as these features do not exist within the Study Area. Five of the islands, Raccoon, Whiskey, and Trinity/East, Wine Islands, are owned and managed as a wildlife refuge by the LDWF, however, there are no LDWF facilities present.

5.15.8.1.2 Indirect

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by boat or aircraft. There are no public facilities or public services on the islands. There would be no indirect impacts of the No Action Alternative on public facilities and services, as these features do not exist within the Study Area. Five of the islands, Raccoon, Whiskey, Trinity/East, and Wine Islands, are managed as a wildlife refuge by the LDWF, however, there are no LDWF facilities present.

5.15.8.1.3 Cumulative

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by boat or aircraft. There are no public facilities or public services on the islands. There would be no cumulative impacts of the No Action Alternative on public facilities and services, as these features do not exist within the Study area. Five of the islands, Raccoon, Whiskey, Trinity/East, and Wine Islands, are managed as a wildlife refuge by the LDWF, however, there are no LDWF facilities present.

5.15.8.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.8.2.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.8.2.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.8.2.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.8.3 Alternative 11: Whiskey (Plan C)

5.15.8.3.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.8.3.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.8.3.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.8.4 Alternative 2: Timbalier (Plan E)

5.15.8.4.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.8.4.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.8.4.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.8.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.8.5.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.8.5.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.8.5.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.8.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.8.6.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.8.6.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.8.6.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.9 Local Government Finance

5.15.9.1 No Action Alternative (Future without Project Conditions)

5.15.9.1.1 Direct

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by shoal-draft boat or aircraft. There are no local government expenditures for public services on the islands. There would be no direct impacts of the No Action Alternative on local government finance, as this aspect of government services is not applicable within the Study Area.

5.15.9.1.2 Indirect

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by shoal-draft boat or aircraft. There are no local government expenditures for public services on the islands. There would be no indirect impacts of the No Action Alternative on local government finance, as this aspect of government services is not applicable within the Study Area.

5.15.9.1.3 Cumulative

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by shoal-draft boat or aircraft. There are no local government expenditures for public services on the islands. There would be no cumulative impacts of the No Action Alternative on local government finance, as this aspect of government services is not applicable within the Study Area.

5.15.9.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.9.2.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.9.2.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.9.2.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.9.3 Alternative 11: Whiskey (Plan C)

5.15.9.3.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.9.3.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.9.3.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.9.4 Alternative 2: Timbalier (Plan E)

5.15.9.4.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.9.4.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.9.4.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.9.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.9.5.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.9.5.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.9.5.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.9.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.9.6.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.9.6.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.9.6.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.10 Tax Revenue and Property Values

The LDWF owns the surface rights to Whiskey Island and Raccoon Island. Mineral rights are privately-owned. LDWF owns the surface rights to the majority of Trinity

Island/East Island. Approximately 30 acres appear to be privately-owned. It appears that this private landowner also owns the underlying mineral rights. The LDWF also owns the majority of Timbalier Island. There appears to be 11 privately-owned tracts on the eastern end of the island as well as private underlying mineral right holders.

5.15.10.1 No Action Alternative (Future without Project Conditions)

5.15.10.1.1 Direct

The direct impact of the No Action Alternative would be the disappearance of all of the islands before the end of the century. There would be no taxable property remaining.

5.15.10.1.2 Indirect

The indirect impact of the No Action Alternative would be the disappearance of all of the islands before the end of the century. There would be no taxable property remaining.

5.15.10.1.3 Cumulative

The cumulative impact of the No Action Alternative would be the disappearance of all of the islands before the end of the century. There would be no taxable property remaining.

5.15.10.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.10.2.1 Direct

The direct impact of implementing the NER Plan, with proposed renourishments, would be to preserve some taxable value of the four islands to the end of the 50-year period of analysis.

5.15.10.2.2 Indirect

The indirect impact to Wine and East Timbalier islands would be a continuation of their existing rate of erosion until they disappear, along with any taxable value.

5.15.10.2.3 Cumulative

The cumulative impact would be similar to the indirect impact.

5.15.10.3 Alternative 11: Whiskey (Plan C)

5.15.10.3.1 Direct

The direct impact of implementing Alternative 11, with proposed renourishments, would be to preserve some taxable value of the single island to the end of the 50-year period of analysis.

5.15.10.3.2 Indirect

The indirect impact to the remaining islands would be a continuation of their existing rate of erosion until they disappear, along with any taxable value.

5.15.10.3.3 Cumulative

The cumulative impact would be similar to the indirect impact.

5.15.10.4 Alternative 2: Timbalier (Plan E)

5.15.10.4.1 Direct

Direct impacts would be similar to Alternative 11.

5.15.10.4.2 Indirect

Indirect impacts would be similar to Alternative 11.

5.15.10.4.3 Cumulative

Cumulative impacts would be similar to Alternative 11.

5.15.10.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.10.5.1 Direct

The direct impact of implementing Alternative 3, with proposed renourishments, would be to preserve some taxable value for both islands to the end of the 50-year period of analysis.

5.15.10.5.2 Indirect

Indirect impacts would be similar to Alternative 11.

5.15.10.5.3 Cumulative

The cumulative impacts would be similar to the indirect impact.

5.15.10.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.10.6.1 Direct

The direct impact of implementing Alternative 4, with proposed renourishments, would be to preserve some taxable value of the three islands to the end of the 50-year period of analysis.

5.15.10.6.2 Indirect

Indirect impacts would be similar to Alternative 11.

5.15.10.6.3 Cumulative

Cumulative impacts would be similar to the indirect impact.

5.15.11 Community and Regional Growth

5.15.11.1 No Action Alternative (Future without Project Conditions)

5.15.11.1.1 Direct

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by boat or aircraft. There would be no direct impacts of the No Action Alternative on community and regional growth, as these features do not exist within the Study Area.

5.15.11.1.2 Indirect

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by boat or aircraft. There would be no indirect impacts of the No Action Alternative on community and regional growth, as these features do not exist within the Study Area.

5.15.11.1.3 Cumulative

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by boat or aircraft. There would be no cumulative impacts of the No Action Alternative on community and regional growth, as these features do not exist within the Study Area.

5.15.11.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.11.2.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.11.2.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.11.2.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.11.3 Alternative 11: Whiskey (Plan C)

5.15.11.3.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.11.3.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.11.3.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.11.4 Alternative 2: Timbalier (Plan E)

5.15.11.4.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.11.4.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.11.4.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.11.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.11.5.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.11.5.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.11.5.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.11.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.11.6.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.11.6.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.11.6.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.12 Land Use Socioeconomics

Agriculture

5.15.12.1 No Action Alternative (Future without Project Conditions)

5.15.12.1.1 Direct

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by boat or aircraft. There are no public facilities on the islands. No agricultural or forestry-related activities are supported. There would be no direct impacts of the No Action Alternative on agriculture or silviculture land use, as these uses do not exist within the Study Area.

5.15.12.1.2 Indirect

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by boat or aircraft. There are no public facilities on the islands. No agricultural or forestry-related activities are supported. There would be no indirect impacts of the No Action Alternative on agriculture or silviculture land use, as these uses do not exist within the Study Area.

5.15.12.1.3 Cumulative

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by boat or aircraft. There are no public facilities on the islands. No agricultural or forestry-related activities are supported. There would be no cumulative impacts of the No Action Alternative on agriculture or silviculture land use, as these uses do not exist within the Study Area.

5.15.12.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.12.2.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.12.2.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.12.2.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.12.3 Alternative 11: Whiskey (Plan C)

5.15.12.3.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.12.3.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.12.3.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.12.4 Alternative 2: Timbalier (Plan E)

5.15.12.4.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.12.4.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.12.4.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.12.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.12.5.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.12.5.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.12.5.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.12.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.12.6.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.12.6.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.12.6.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

Forestry

5.15.12.7 No Action Alternative (Future without Project Conditions)

5.15.12.7.1 Direct

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by boat or aircraft. There are no public facilities on the islands. No agricultural or forestry-related activities are supported. There would be no direct impacts of the No Action Alternative on agriculture or silviculture land use, as these uses do not exist within the Study Area.

5.15.12.7.2 Indirect

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by boat or aircraft. There are no public facilities on the islands. No agricultural or forestry-related activities are supported. There would be no indirect impacts of the No Action Alternative on agriculture or silviculture land use, as these uses do not exist within the Study Area.

5.15.12.7.3 Cumulative

The Study Area consists of two reaches of a chain of remote, uninhabited barrier islands, accessible only by boat or aircraft. There are no public facilities on the islands. No agricultural or forestry-related activities are supported. There would be no cumulative impacts of the No Action Alternative on agriculture or silviculture land use, as these uses do not exist within the Study Area.

5.15.12.8 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.12.8.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.12.8.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.12.8.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.12.9 Alternative 11: Whiskey (Plan C)

5.15.12.9.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.12.9.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.12.9.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.12.10 Alternative 2: Timbalier (Plan E)

5.15.12.10.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.12.10.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.12.10.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.12.11 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.12.11.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.12.11.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.12.11.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

5.15.12.12 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.12.12.1 Direct

Direct impacts would be the same as the No Action Alternative.

5.15.12.12.2 Indirect

Indirect impacts would be the same as the No Action Alternative.

5.15.12.12.3 Cumulative

Cumulative impacts would be the same as the No Action Alternative.

Public Lands

5.15.12.13 No Action Alternative (Future without Project Conditions)

5.15.12.13.1 Direct

There would be no direct impacts of the No Action Alternative on public lands within the Study Area. Not implementing barrier restoration features would result in the persistence of existing conditions.

5.15.12.13.2 Indirect

The indirect impacts on public lands in the region that would most likely be affected under the No Action Alternative are those related to the loss of wetlands and habitat diversity.

As wetland degradation and the high rates of land loss continues throughout the area, wildlife abundance would continue to decrease. The local abundance of resident transitional wetland-dependent wildlife would likely decrease. These species would have to relocate to find more suitable transitional wetland habitats. Migratory birds would be required to find other, more suitable stopover habitats on their trans-Gulf migrations. With the continued conversion of transitional estuarine wetlands to open water, estuarine fishery abundance and diversity would be expected to decline over time. Lower quality fishery spawning, nursery, and foraging habitat would translate to a decline in sport fishing success in the future as the usage by game species decline, so would the hunting opportunities and the usage by migratory birds decline, so would the opportunities for viewing.

5.15.12.13.3 Cumulative

Cumulative impacts would be the synergistic effect of the No-Action Alternative on public lands with the additive combination of similar impacts from wetland loss and degradation throughout coastal Louisiana on public lands, as well as the benefits and impacts of other State and Federal projects in the vicinity.

5.15.12.14 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.12.14.1 Direct

The primary direct impacts on public lands would result from the Study Area being temporarily unavailable during construction. In addition, there would be a temporary decrease in the quality of recreational opportunities as the wetland creation and nourishment sites re-vegetates, usually within 9 to 12 months, following completion of construction.

5.15.12.14.2 Indirect

Alternative 5 (NER Plan) would protect, create and nourish transitional estuarine wetlands. Following construction, these transitional estuarine wetlands would provide important and essential fish and wildlife habitats that would contribute to restoring the base of organisms used for recreational activities such as fishing and camping. Increased recreation activities and public land use would come from expansion of new vegetative habitat on newly created areas and the relief from flooding frequency stressors that those areas would afford existing habitats.

5.15.12.14.3 Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 5 (NER Plan) with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, State, local, and private restoration efforts. Alternative 5 (NER Plan) would work synergistically with those projects to provide more complete protection for barrier islands, which would continue to provide wetland-dependent recreational opportunities on public lands within the Study Area.

5.15.12.15 Alternative 11: Whiskey (Plan C)

5.15.12.15.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan).

5.15.12.15.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan).

5.15.12.15.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan).

5.15.12.16 Alternative 2: Timbalier (Plan E)

5.15.12.16.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan).

5.15.12.16.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan).

5.15.12.16.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan).

5.15.12.17 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.12.17.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan).

5.15.12.17.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan).

5.15.12.17.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan).

5.15.12.18 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.12.18.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan).

5.15.12.18.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan).

5.15.12.18.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan).

5.15.13 Water Use and Supply

5.15.13.1 No Action Alternative (Future without Project Conditions)

5.15.13.1.1 Direct

The Terrebonne Basin Barrier Islands have no public infrastructure, such as streets, potable water supply and distribution, and wastewater collection and treatment. The islands are uninhabited and undeveloped and inaccessible except by boat or aircraft. There would be no direct impacts of the No Action Alternative on water use and water supply, as these features do not exist within the Study Area.

5.15.13.1.2 Indirect

The Terrebonne Basin Barrier Islands have no public infrastructure, such as streets, potable water supply and distribution, and wastewater collection and treatment. The islands are uninhabited and undeveloped and inaccessible except by boat or aircraft. There would be no indirect impacts of the No Action Alternative on water use and water supply, as these features do not exist within the Study Area.

5.15.13.1.3 Cumulative

The Terrebonne Basin Barrier Islands have no public infrastructure, such as streets, potable water supply and distribution, and wastewater collection and treatment. The islands are uninhabited and undeveloped and inaccessible except by boat or aircraft. There would be no cumulative impacts of the No Action Alternative on water use and water supply, as these features do not exist within the Study Area.

5.15.13.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.13.2.1 Direct

There would be no direct impact on the water supplies in this area.

5.15.13.2.2 Indirect

There would be no indirect impact on the water supplies in this area.

5.15.13.2.3 Cumulative

There would be no cumulative impact on the water supplies in this area.

5.15.13.3 Alternative 11: Whiskey (Plan C)

5.15.13.3.1 Direct

There would be no direct impact on the water supplies in this area.

5.15.13.3.2 Indirect

There would be no indirect impact on the water supplies in this area.

5.15.13.3.3 Cumulative

There would be no cumulative impact on the water supplies in this area.

5.15.13.4 Alternative 2: Timbalier (Plan E)

5.15.13.4.1 Direct

There would be no direct impact on the water supplies in this area.

5.15.13.4.2 Indirect

There would be no indirect impact on the water supplies in this area.

5.15.13.4.3 Cumulative

There would be no cumulative impact on the water supplies in this area.

5.15.13.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.13.5.1 Direct

There would be no direct impact on the water supplies in this area.

5.15.13.5.2 Indirect

There would be no indirect impact on the water supplies in this area.

5.15.13.5.3 Cumulative

There would be no cumulative impact on the water supplies in this area.

5.15.13.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.13.6.1 Direct

There would be no direct impact on the water supplies in this area.

5.15.13.6.2 Indirect

There would be no indirect impact on the water supplies in this area.

5.15.13.6.3 Cumulative

There would be no cumulative impact on the water supplies in this area.

5.15.14 Navigation

The two reaches of Terrebonne Basin Barrier Islands, the Isles Dernieres and Timbalier Reaches, are bisected by the Houma Navigation Canal, which empties into the Gulf of Mexico at Cat Island Pass, between Trinity-East and Timbalier Islands. The HNC is a Federal channel, maintained by the New Orleans District of the USACE. Elsewhere in the Basin there are numerous privately-maintained and marked channels, where safe navigation depends solely on local knowledge.

5.15.14.1 No Action Alternative (Future without Project Conditions)

5.15.14.1.1 Direct

The No Action Alternative, not implementing the barrier island restoration features, would have no immediate direct impacts on navigation in the Study Area.

5.15.14.1.2 Indirect

Indirect impacts would result from the persistence of existing conditions, including continued degradation of the barrier islands, loss of their associated wetlands, and loss of interior wetlands north of the Study Area. This continued wetland loss may affect navigability and maintenance of both the federally- and privately-maintained waterways, including the Houma Navigation Canal and several smaller bayous.

5.15.14.1.3 Cumulative

The cumulative impact of the No Action Alternative could change access, cost, and frequency of maintenance for the federally maintained waterways that transect Terrebonne and Timbalier Bays and pass near the Study Area.

5.15.14.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.14.2.1 Direct

The direct impact from implementing the NER Plan would be temporary disruption of recreational and commercial vessel traffic in the vicinity of each island during construction.

5.15.14.2.2 Indirect

The direct impact from implementing the NER Plan would be temporary disruption of recreational and commercial vessel traffic in the vicinity of each island during construction.

5.15.14.2.3 Cumulative

Cumulative impacts, assuming the proposed renourishment events occur, would be a reduction in the impact on waterway shoaling and waterway maintenance costs.

5.15.14.3 Alternative 11: Whiskey (Plan C)

5.15.14.3.1 Direct

The direct impact of implementing the first component of construction would be temporary disruption of vessel traffic in the vicinity of the island during construction.

5.15.14.3.2 Indirect

The indirect impact of implementing the first component of construction would be temporary disruption of vessel traffic in the vicinity of the dredge at the borrow area.

5.15.14.3.3 Cumulative

Implementing this alternative would have a cumulative impact on commercial and recreational vessel traffic by some undetermined level during construction along the barrier islands being restored.

5.15.14.4 Alternative 2: Timbalier (Plan E)

5.15.14.4.1 Direct

Direct impacts would be similar to Alternative 11.

5.15.14.4.2 Indirect

Indirect impacts would be similar to Alternative 11.

5.15.14.4.3 Cumulative

Cumulative impacts would be similar to Alternative 11.

5.15.14.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.14.5.1 Direct

Direct impacts would be similar to Alternative 11.

5.15.14.5.2 Indirect

Indirect impacts would be similar to Alternative 11.

5.15.14.5.3 Cumulative

Cumulative impacts would be similar to Alternative 11.

5.15.14.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.14.6.1 Direct

Direct impacts would be similar to Alternative 11.

5.15.14.6.2 Indirect

Indirect impacts would be similar to Alternative 11.

5.15.14.6.3 Cumulative

Cumulative impacts would be similar to Alternative 11.

5.15.15 Man-Made Resources

Oil, Gas, Utilities, Pipelines

5.15.15.1 No Action Alternative (Future without Project Conditions)

5.15.15.1.1 Direct

The mineral-rich subsurface of the Terrebonne Basin has significantly contributed to the State's thriving oil and gas industry. According to the SONRIS database, there are a total of 1,109 wells, 12 pipelines, and 396 pits found in the vicinity of the Study Area (LDNR 2009). The No Action Alternative would have no direct impacts on oil and gas activities or infrastructure since there will be no disturbance to the island footprints or the borrow areas.

5.15.15.1.2 Indirect

Pipeline crossings occur within the island footprints, between the islands, and within the vicinity of the islands. These pipelines are used to transport oil crude and natural gas from wells to facilities scattered throughout the Terrebonne Basin. As previously stated, there are a total of 12 oil and gas pipelines within the Study Area, eleven of which are currently active. Table 5-10 presents active oil and gas pipelines in or near the islands (LDNR 2009). There are also numerous pipelines that intersect the proposed borrow areas.

Table 5-10. Pipelines in the Vicinity of the Study Area*

Pipeline ID	Company	Status	Location
1498	United Gas Pipeline Company	Active	East Timbalier
2778	Duke Energy Hydrocarbons, LLC	Active	East Timbalier
3604	Chevron Pipeline Co.	Active	East Timbalier
3043	Tennessee Gas Transmission Company	Active	East Timbalier
5796 \ 5797	California Oil Company	Abandoned	East Timbalier
2567	Equilon Pipeline Company, LLC	Active	Western Portion of Timbalier

Pipeline ID	Company	Status	Location
9882	Louisiana Offshore Gathering S	Active	Eastern Portion of Timbalier
6138	Comstock Offshore, LLC	Active	Between East and Wine Islands
9145	Bayou City Pipelines, INC	Active	Between Whiskey and Trinity Islands
3860	Williams Field Service Co.	Active	East of Raccoon Island
7602	Trunkline Gas Company	Active	West of Raccoon Island

*These pipelines represent the active oil and gas pipelines that were identified in the SONRIS database (LDNR, 2009). Additional investigations, including field verification, will be conducted during PED to refine this list

Indirect impacts of not implementing wetland creation/nourishment and shoreline protection features would result in the persistence of existing conditions including the fragmentation and degradation of the existing barrier islands and inland marshes. The unimpeded erosion of these areas will continue to uncover pipelines that have been buried both on the islands and on the seafloor. As these pipelines are exposed, they will become susceptible weathering, boat collisions, and impacts from anchor dragging. Furthermore, erosion of the sediments surrounding the pipelines could compromise the structural integrity of the pipelines and their associated infrastructure. Damage to oil and gas pipelines could potentially result in releases of petroleum products to the environmental. This will not only have a considerable environmental impact, but will also have an impact on production. In addition, cleanup costs could be substantial.

Timbalier and East Timbalier Islands are the only two islands in the Study Area that host active oil and gas facilities. These facilities include a combination of active and inactive wells, platforms, tank batteries, housing infrastructure, and pits. Continued erosion of the beaches and dunes could eventually expose these facilities to direct hurricane impacts. This could potentially result in spills, damaged to infrastructure, and lost revenues.

5.15.15.1.3 Cumulative

The combined, incremental effects of the No Action alternative and the continued degradation of Louisiana's barrier coastline could have a significant adverse impact on the oil and gas infrastructure in the Study Area over the 50-year period of analysis. These impacts include exposure of the pipelines and infrastructure to direct hurricane forces and navigational hazards. Although existing State and Federal restoration projects within or near the Study Area will help to lessen these impacts, they are not sufficient to reverse the process.

5.15.15.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.15.2.1 Direct

Although there are numerous pipelines within the Study Area, Timbalier Island is the only island in the NER Plan with pipelines that are located within the proposed template. The construction of the NER Plan will benefit these pipelines by further covering them will fill material. This will provide a protective barrier from weather-related impacts as well as impacts associated with the day-to-day operation of the oil and gas facilities. During PED, these pipelines will be clearly marked so that they are not damaged while dredging the back-barrier access channels.

The pipelines running through the Ship Shoal, South Pelto, Whiskey 3a, New Cut, and Raccoon borrow areas could be directly impacted during the sediment mining activities. However, these impacts are highly unlikely because the pipelines will be clearly identified during PED. Also, a buffer zone will be applied to each pipeline to provide additional protection during construction. Contractors will not be allowed to dredge within the buffer zone.

5.15.15.2.2 Indirect

As previously stated, the NER Plan will benefit the existing pipelines on Timbalier Island by providing additional protection from impacts. This could potentially reduce the susceptibility of the pipelines to petroleum releases. The indirect benefits of pipeline protection include a reduction in environmental risks (petroleum impacts on wildlife and habitat) and economic risks (downtime, lost product, spill cleanup costs). Furthermore, the oil and gas facilities on Timbalier Island will indirectly benefit from the additional protection provided by the restored dune and beaches that are gulfward of the facilities.

Oil and gas infrastructure within the bays and on the mainland behind Raccoon, Whiskey, Trinity, and Timbalier Island would also benefit from the additional storm surge and wave protection afforded by the restored islands.

There are no relocations of pipelines or oil and gas infrastructure associated with construction or renourishment of the NER Plan.

5.15.15.2.3 Cumulative

When compared to the No Action Alternative, the combined, incremental effects of the NER Plan and the existing coastal restoration projects within or adjacent to the Study Area are expected to provide additional protection for the oil and gas pipelines and infrastructure over the 50-year period of analysis.

5.15.15.3 Alternative 11: Whiskey (Plan C)

5.15.15.3.1 Direct

There are no oil and gas pipelines or infrastructure located within the proposed template for Whiskey Island Plan C. Therefore, placement of fill on the island will not have any direct impacts on oil and gas activities.

The pipelines running through the Ship Shoal and Whiskey 3 borrow areas could be directly impacted during the sediment mining activities. However, as with the NER Plan, these impacts are highly unlikely because the pipelines will be clearly identified during PED. Also, a buffer zone will be applied to each pipeline to provide additional protection during construction. Contractors will not be allowed to dredge within the buffer zone.

5.15.15.3.2 Indirect

Oil and gas infrastructure within the bays and on the mainland behind Whiskey Island will indirectly benefit from the first component of construction since the restoration features will provide enhanced protection from storm surge and wave impacts. There are no relocations of pipelines or oil and gas infrastructure associated with construction or renourishment of the first component of construction.

5.15.15.3.3 Cumulative

When compared to the No Action Alternative, the combined, incremental effects of the first component of construction and the existing coastal restoration projects within or adjacent to the Study Area are expected to provide additional protection for the oil and gas pipelines and infrastructure over the 50-year period of analysis. However, the level of protection provided by the first component of construction will be less than that provided by the NER Plan since only one island is being restored.

5.15.15.4 Alternative 2: Timbalier (Plan E)

5.15.15.4.1 Direct

Construction of Timbalier Plan E will directly benefit the two active pipelines that are on the island by further covering them will fill material. This will provide a protective barrier from weather-related impacts as well as impacts associated with the day-to-day operation of the oil and gas facilities. During PED, these pipelines will be clearly marked so that they are not damaged while dredging the back-barrier access channels.

The pipelines running through the South Pelto and Whiskey 3a borrow areas could be directly impacted during the sediment mining activities. However, these impacts are highly unlikely because the pipelines will be clearly identified during PED. Also, a buffer zone will be applied to each pipeline to provide additional protection during construction. Contractors will not be allowed to dredge within the buffer zone.

5.15.15.5 Indirect

Construction of Timbalier Plan E could potentially reduce the susceptibility of the two existing pipelines on the island to petroleum releases. This wood translate to a reduction in environmental risks (petroleum impacts on wildlife and habitat) and economic risks (downtime, lost product, spill cleanup costs). Furthermore, the oil and gas facilities on Timbalier Island will indirectly benefit from the additional protection provided by the restored dune and beaches that are gulfward of the facilities. There are no relocations of pipelines or oil and gas infrastructure associated with construction or renourishment of Alternative 2.

5.15.15.5.1 Cumulative

When compared to the No Action Alternative, the combined, incremental effects of Alternative 2 and the existing coastal restoration projects within or adjacent to the Study Area are expected to provide additional protection for the oil and gas pipelines and infrastructure over the 50-year period of analysis. The cumulative hydrologic impacts of Alternative 2 would be greater than that of the first component of construction (a smaller island plan), but less than that of the NER Plan (a four-island plan).

5.15.15.6 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.15.6.1 Direct

There is no oil and gas infrastructure on Whiskey Island. Construction of Timbalier Plan E, however, will directly benefit the two active pipelines that are on the island by further covering them with fill material and providing a protective barrier.

The pipelines running through the Ship Shoal, South Pelto, Whiskey 3a, and Raccoon borrow areas could be directly impacted during the sediment mining activities. However, these impacts are highly unlikely because the pipelines will be clearly identified during PED. Also, a buffer zone will be applied to each pipeline to provide additional protection during construction. Contractors will not be allowed to dredge within the buffer zone.

5.15.15.6.2 Indirect

As with Alternative 2, construction of Timbalier Plan E could potentially reduce the susceptibility of the two existing pipelines on the island to petroleum releases. This would translate to a reduction in environmental and economic risks. Furthermore, the oil and gas facilities on Timbalier Island will indirectly benefit from the additional protection provided by the restored dune and beaches that are gulfward of the facilities. Oil and gas infrastructure within the bays and on the mainland behind Whiskey Island would also benefit from the additional storm surge and wave protection afforded by the restored islands.

There are no relocations of pipelines or oil and gas infrastructure associated with construction or renourishment of Alternative 3.

5.15.15.6.3 Cumulative

When compared to the No Action Alternative, the combined, incremental effects of Alternative 3 and the existing coastal restoration projects within or adjacent to the Study Area are expected to provide additional protection for the oil and gas pipelines and infrastructure over the 50-year period of analysis. The cumulative hydrologic impacts of Alternative 3 would be greater than that of Alternative 2 (a one-island plan), but less than that of the NER Plan (a four-island plan).

5.15.15.7 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.15.7.1 Direct

There is no oil and gas infrastructure on Whiskey or Trinity Island. Construction of Timbalier Plan E, however, will directly benefit the two active pipelines that are on the island by further covering them with fill material and providing a protective barrier.

The pipelines running through the Ship Shoal, South Pelto, Whiskey 3a, New Cut, and Raccoon borrow areas could be directly impacted during the sediment mining activities. However, these impacts are highly unlikely because the pipelines will be clearly identified during PED and will be protected with a buffer.

5.15.15.7.2 Indirect

The indirect benefits of Alternative 4 would be very similar to Alternative 3. Construction of Timbalier Plan E could potentially reduce the susceptibility of the two existing pipelines on the island to petroleum releases. This would translate to a reduction in environmental and economic risks. Furthermore, the oil and gas facilities on Timbalier Island will indirectly benefit from the additional protection provided by the restored dune and beaches that are gulfward of the facilities. Oil and gas infrastructure within the bays and on the mainland behind Whiskey and Trinity Island would also benefit from the additional storm surge and wave protection afforded by the restored islands.

There are no relocations of pipelines or oil and gas infrastructure associated with construction or renourishment of Alternative 4.

5.15.15.7.3 Cumulative

When compared to the No Action Alternative, the combined, incremental effects of Alternative 4 and the existing coastal restoration projects within or adjacent to the Study Area are expected to provide additional protection for the oil and gas pipelines and infrastructure over the 50-year period of analysis. The cumulative hydrologic impacts of Alternative 4 would be greater than that of Alternative 3 (a two-island plan), but less than that of the NER Plan (a four-island plan).

Flood Control and Hurricane Protection

5.15.15.8 No Action Alternative (Future without Project Conditions)

5.15.15.8.1 Direct

The Study Area is remote and uninhabited. There are no flood control or hurricane protection levees in the area. The No Action Alternative would have no direct impact. The existing trends, including continued wetland loss and degradation of the barrier islands, would persist, with the islands becoming increasingly vulnerable to storm surge overwash and erosion.

5.15.15.8.2 Indirect

Without any action, approximately 2,811 acres of existing barrier resources from the seven island Terrebonne Basin barrier system (East Timbalier, Timbalier, Trinity, East Island, Wine, Whiskey and Raccoon Island) would likely continue to deteriorate, degrade, fragment and eventually convert into shallow open water bottoms. If the Terrebonne Basin barrier island system is not restored, the adjacent estuarine bay systems, along with the interior coastal marshes, will continue to be transformed into marine open water habitat.

5.15.15.8.3 Cumulative

There would be no cumulative impacts of the No Action Alternative on flood control or hurricane protection levees, as this resource does not exist within the Study Area. However, modeling studies conducted by Stone, *et al*. (2005) have demonstrated that loss of the barrier islands and associated oyster reefs has had, and will continue to have, a significant effect on wave heights in the adjacent bays and their fringing marshes. Not implementing barrier restoration features will result in the persistence of island erosion and wetland loss, both on the islands and in the bays to the north.

5.15.15.9 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.15.9.1 Direct

The direct impact of implementing the NER Plan on flood control is not an applicable issue, because there are no flood control levees in the Study Area. Regarding hurricane protection, the proposed minimum island design restoration template retains island geomorphic form and ecologic function and prevents breaching when subjected to the impacts of two pairs of historic hurricanes (Katrina/Rita and Gustav/Ike) and a theoretical 50-year storm. The proposed template will add sufficient width and elevation to the islands for them to survive similar hurricanes.

5.15.15.9.2 Indirect

The indirect impacts of implementing the NER Plan would be an undetermined reduction in wave height in the bays to the north (Lake Pelto and Terrebonne and Timbalier Bays), and a concomitant reduction in marsh and bay island erosion. The NER Plan would also reduce storm surge to some degree further north in the Terrebonne Basin and potentially reduce the storm surge-related stresses placed upon existing and planned flood control structures.

5.15.15.9.3 Cumulative

Cumulative impacts would be a combination of the above-referenced direct and indirect impacts, assuming the proposed renourishment events occur.

5.15.15.10 Alternative 11: Whiskey (Plan C)

5.15.15.10.1 Direct

Implementing this alternative would have the direct impact of protecting the restored Whiskey Island beach, dune, and marsh from storm surges and erosion.

5.15.15.10.2 Indirect

Implementing this alternative would have an undetermined indirect impact of protecting the adjacent wetlands of Lake Pelto from storm surges and erosion. Alternative 11 would also provide storm surge-related benefits, albeit to a lesser degree than the NER Plan.

5.15.15.10.3 Cumulative

Implementing this alternative, assuming the proposed renourishment events occur, would have the cumulative impact of providing an undetermined level of protection for Whiskey Island and the nearby wetlands of Lake Pelto from storm surges and erosion. Increasing and maintaining the restored acreage would contribute to a reduction of storm surge and wave heights in the area.

5.15.15.11 Alternative 2: Timbalier (Plan E)

5.15.15.11.1 Direct

Direct impacts of implementing Alternative 2 would be similar to Alternative 11.

5.15.15.11.2 Indirect

The indirect impacts for Timbalier Island would be similar to those for Whiskey Island, Alternative 11.

5.15.15.11.3 Cumulative

The cumulative impacts would be similar to Alternative 11, however the storm surge and wave height reductions would not be as significant, because the wetlands to the north are at a greater distance.

5.15.15.12 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.15.12.1 Direct

The direct impacts would be a combination of Alternatives 11 (first component of construction) and Alternative 2.

5.15.15.12.2 Indirect

The indirect impacts would be a combination of Alternatives 11 (first component of construction) and Alternative 2.

5.15.15.12.3 Cumulative

The cumulative impacts would be a combination of Alternatives 11 (first component of construction) and Alternative 2.

5.15.15.13 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.15.13.1 Direct

The direct impacts would be similar to Alternative 5 (NER Plan), but reduced in scale because the alternative involves only three islands.

5.15.15.13.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan), but reduced in scale because the alternative involves only three islands.

5.15.15.13.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan), but reduced in scales because the alternative .involves only thee islands.

5.15.16 Natural Resources

Commercial Fisheries

5.15.16.1 No Action Alternative (Future without Project Conditions)

5.15.16.1.1 Direct

The No Action Alternative, not implementing barrier island restoration features, would have no direct impacts on commercial fisheries. Existing conditions would persist. The continued wetland habitat losses within the Study Area, combined with widespread coastal wetland loss throughout coastal Louisiana, would contribute to the overall decrease in productivity of Louisiana's coastal fisheries. Louisiana provides more fishery landings than any other State in the conterminous United States (more than 1.1 billion pounds/year), and more than 75% of Louisiana's commercially harvested fish and shellfish species are dependent on wetlands (LSU, http://lamer.lsu.edu/projects/ oceancommotion/facts.htm).

5.15.16.1.2 Indirect

Wetland habitat losses in the Study Area would contribute to the overall decrease in productivity of these fisheries throughout coastal Louisiana. For example, menhaden and other finfish species, shrimp, and blue crabs all depend upon the estuaries for critical stages in their life cycles.

As much as 16% of the nation's fisheries' harvests, including shrimp, crabs, crawfish, oysters, and numerous finfish species, come from Louisiana's coast (http://lamer.lsu.edu/projects/oceancommotion/facts.htm). The seafood industry would likely suffer significant losses in employment as estuaries that are necessary to produce shrimp, oysters, and other valuable species continue to diminish in area and in productivity. Job losses would likely occur in the areas reliant on fishing, harvesting, processing, and shipping of the seafood catch.

5.15.16.1.3 Cumulative

The seafood industry would likely suffer significant losses in employment and revenue as the estuarine natural resources, which are necessary to produce shrimp, oysters, and other valuable species, continue to erode. Job losses would occur in the areas of fishing, harvesting, processing, and shipping of seafood catch.

5.15.16.2 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.16.2.1 Direct

The direct impact from implementing the NER Plan would be temporary disruption of commercial fishing vessel traffic in the vicinity of each island during construction.

5.15.16.2.2 Indirect

The indirect impact from implementing the NER Plan would be a temporary disruption of commercial fishing vessel traffic in the vicinity of the dredge over the borrow area during construction.

5.15.16.2.3 Cumulative

The cumulative impact from implementing the NER Plan, assuming the proposed renourishment events occur, would be a reduction in the rate of decline of the productivity of the estuary, leading to a reduction in the rate of decline of the fisheries resources.

5.15.16.3 Alternative 11: Whiskey (Plan C)

5.15.16.3.1 Direct

Implementing this alternative would have a short term direct impact on commercial fishing activity within the Study Area during the period of construction. The seafood industry would have to operate away from the construction area and would suffer a temporary loss of revenue until the disruption on marine life is abated.

5.15.16.3.2 Indirect

Implementing this alternative would have an indirect impact on commercial fishing activity in the vicinity of the dredge over the borrow area during the period of construction.

5.15.16.3.3 Cumulative

The cumulative impact of implementing this alternative would be derived from the additional productive marsh area created and from the adjacent marsh areas protected from storm damage by the restored and renourished island. Assuming that the other barrier islands continue to erode throughout the period of analysis, this single island's impact is probably negligible.

5.15.16.4 Alternative 2: Timbalier (Plan E)

5.15.16.4.1 Direct

Direct impacts would be similar to Alternative 11.

5.15.16.4.2 Indirect

Indirect impacts would be similar to Alternative 11.

5.15.16.4.3 Cumulative

Cumulative impacts would be similar to Alternative 11, without the referenced protection afforded the adjacent wetland.

5.15.16.5 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.16.5.1 Direct

Direct impacts would be similar to Alternative 11.

5.15.16.5.2 Indirect

Indirect impacts would be similar to Alternative 11.

5.15.16.5.3 Cumulative

Cumulative impacts would be similar to Alternative 11.

5.15.16.6 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.16.6.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan).

5.15.16.6.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan).

5.15.16.6.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan).

Oyster Leases

Oysters feed by filtering suspended material, including organic detritus and phytoplankton, from the water that flows past them. The loss of estuarine wetlands not only reduces detritus, which is used directly by oysters, but also reduces generation of catabolic substances (i.e. produced by catabolism, a process by which complex organic molecules are converted to more simple compounds) that are more readily utilized by primary producers (e.g., phytoplankton), which are then consumed by oysters and other organisms (Kilgen and Dugas 1989). Oyster larvae depend on estuaries for protection and food until they settle out of the water column onto a hard substrate.

5.15.16.7 No Action Alternative (Future without Project Conditions)

5.15.16.7.1 Direct

The No Action Alternative, not implementing barrier island restoration features, would have no immediate direct impacts on oyster leases. Existing conditions would persist.

5.15.16.7.2 Indirect

The ongoing loss of wetlands in the Study Area would alter the detritus-based food web of the oyster thereby reducing the localized carrying capacity of the oyster leases in the area.

5.15.16.7.3 Cumulative

Cumulative impacts would be eventual loss of barrier and wetland habitats, which in turn, would result in increased salinity conditions and decreased food supply, making these areas unsuitable for the viable culture of oysters.

5.15.16.8 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.16.8.1 Direct

The immediate direct impacts to oyster leases would include disturbance to water bottoms from the placement of dredged material. Other direct impacts during construction would include disturbance and/or mortality due to increased turbidity and decreased dissolved oxygen from increased biological oxygen demand (BOD). Once construction is completed the direct impact of implementing the NER Plan would be stabilization of the barrier islands, thus providing additional sheltered habitat for oyster settlement, and creation of additional marsh habitat, leading to increased production of detritus and catabolic compounds.

5.15.16.8.2 Indirect

The immediate indirect impact to oyster leases could be increased stress from turbidity generated by the restoration construction. Following completion of construction, the indirect impact would be the increased production of detritus and catabolic compounds, which are carried by tidal flow to adjacent areas, thus benefiting neighboring oyster lease areas.

5.15.16.8.3 Cumulative

The cumulative impact of implementing the NER Plan, assuming the proposed renourishment events occur, would be a continuation and expansion of the post-construction indirect impact to a larger area of the Terrebonne Basin for the course of the period of analysis.

5.15.16.9 Alternative 11: Whiskey (Plan C)

5.15.16.9.1 Direct

The direct impacts to oyster leases would be the same as the NER Plan, applied to a single island.

5.15.16.9.2 Indirect

There would be minimal, localized indirect impacts to oyster leases in areas adjacent to the construction area, due to increased turbidity and siltation caused by fill placement.

5.15.16.9.3 Cumulative

The cumulative impact of this alternative would be similar to that for the NER Plan, at a scale applicable to a single island.

5.15.16.10 Alternative 2: Timbalier (Plan E)

5.15.16.10.1 Direct

Direct impacts would be similar to Alternative 11.

5.15.16.10.2 Indirect

Indirect impacts would be similar to Alternative 11.

5.15.16.10.3 Cumulative

Cumulative impacts would be similar to Alternative 11.

5.15.16.11 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.15.16.11.1 Direct

Direct impacts would be similar to Alternative 11 but increased in scale to account for two islands.

5.15.16.11.2 Indirect

Indirect impacts would be similar to Alternative 11 but increased in scale to account for two islands.

5.15.16.11.3 Cumulative

Cumulative impacts would be similar to Alternative 11 but increased in scale to account for two islands.

5.15.16.12 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.15.16.12.1 Direct

Direct impacts would be similar to Alternative 11 but increased in scale to account for three islands.

5.15.16.12.2 Indirect

Indirect impacts would be similar to Alternative 11, but increased in scale to account for three islands.

5.15.16.12.3 Cumulative

Cumulative impacts would be similar to Alternative 11, but increased in scale to account for three islands.

5.16 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTES

[Phase I Environmental Site Assessment Findings]

5.16.1.1 No Action Alternative (Future without Project Conditions)

5.16.1.2 Direct

Based on current and historical uses of the Study Area for oil and gas exploration and development, there is reason to believe that the potential to encounter HTRW problems would be moderate. Furthermore, increased susceptibility of oil and gas infrastructure to coastal processes could increase the potential for HTRW within the Study Area.

5.16.1.2.1 Indirect

The condition with the No-Action Alternative regarding the potential for HTRW is dependent on site-specific HTRW discovery. Based on previous HTRW studies in the Study Area, there is reason to believe that the potential to encounter HTRW problems would be moderate.

5.16.1.2.2 Cumulative

The condition with the No-Action Alternative regarding the potential for HTRW is dependent on site-specific HTRW discovery. Based on previous HTRW studies in the Study Area, there is reason to believe that the potential to encounter HTRW problems would be moderate.

5.16.1.3 Alternative 5 (NER Plan): Raccoon w/TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.16.1.3.1 Direct

An HTRW investigation of the Study Area was conducted. Based upon findings from this investigation, there are several petroleum pipelines in the area, but as long as they are not damaged the potential for direct impacts to the Study Area from implementation of Alternative 5 (NER Plan) would be low and would likely continue to be low into the future.

5.16.1.3.2 Indirect

An HTRW investigation of the Study Area was conducted. Based upon findings from this investigation, there are several petroleum pipelines in the area, but as long as they are not damaged the potential for indirect impacts to the Study Area from implementation of Alternative 5 (NER Plan) would be low and would likely continue to be low into the future.

5.16.1.3.3 Cumulative

An HTRW investigation of the Study Area was conducted. Based upon findings from this investigation, there are several petroleum pipelines in the area, but as long as they are not damaged the potential for cumulative impacts to the Study Area from implementation of Alternative 5 (NER Plan) would be low and would likely continue to be low into the future.

5.16.1.4 Alternative 11: Whiskey (Plan C)

5.16.1.4.1 Direct

An HTRW investigation of the Study Area was conducted. Based upon findings from this investigation, there are several petroleum pipelines in the area, but as long as they are not damaged the potential for direct impacts to the Study Area from implementation of Alternative 11 would be low and would likely continue to be low into the future.

5.16.1.4.2 Indirect

An HTRW investigation of the Study Area was conducted. Based upon findings from this investigation, there are several petroleum pipelines in the area, but as long as they are not damaged the potential for indirect impacts to the Study Area from implementation of Alternative 11 would be low and would likely continue to be low into the future.

5.16.1.4.3 Cumulative

An HTRW investigation of the Study Area was conducted. Based upon findings from this investigation, there are several petroleum pipelines in the area, but as long as they are not damaged the potential for cumulative impacts to the Study Area from implementation of Alternative 11 would be low and would likely continue to be low into the future.

5.16.1.5 Alternative 2: Timbalier (Plan E)

5.16.1.5.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan).

5.16.1.5.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan).

5.16.1.5.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan).

5.16.1.6 Alternative 3: Whiskey (Plan C) / Timbalier (Plan E)

5.16.1.6.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan).

5.16.1.6.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan).

5.16.1.6.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan).

5.16.1.7 Alternative 4: Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)

5.16.1.7.1 Direct

Direct impacts would be similar to Alternative 5 (NER Plan).

5.16.1.7.2 Indirect

Indirect impacts would be similar to Alternative 5 (NER Plan).

5.16.1.7.3 Cumulative

Cumulative impacts would be similar to Alternative 5 (NER Plan).

6.0 PUBLIC INVOLVEMENT

6.1 NEPA SCOPING

The USACE published a Notice of Intent (NOI) to prepare a Supplemental Environmental Impact Statement (SEIS) for the LCA Terrebonne Basin Barrier Shoreline Restoration Feasibility Study (Terrebonne Basin Barrier Shoreline Restoration Study) in the *Federal Register* (volume 73, number 246) on December 22, 2008.

The purpose of the NOI was to announce the USACE intention to prepare a SEIS that addresses the LCA TBBSR Study, which was identified in the 2004 LCA Ecosystem Restoration Plan as a near-term critical restoration project.

NEPA requires an early and open public process for determining the scope of issues, resources, impacts, and alternatives to be addressed in an EIS. This process is referred to as scoping. Scoping meeting announcements were advertised in three area newspapers before the meeting date. The meeting was held on Tuesday, February 10, 2009, in Houma, Louisiana.

NEPA affords all persons, organizations and government agencies the right to review and comment on proposed major Federal actions that are evaluated by a NEPA document. This is known as the “scoping process.” The scoping process is the initial step in the preparation of the EIS and will help identify (1) the range of actions (project, procedural changes), (2) alternatives (both those to be rigorously explored and evaluated and those that may be eliminated), and (3) the range of environmental resources considered in the evaluation of environmental impacts.

A scoping meeting announcement requesting comments regarding the scope of the Terrebonne Basin Barrier Shoreline Restoration Study was sent to Federal, State, and local agencies; and interested groups and individuals on January 7, 2009. The media advisory announcing the scoping meeting was provided to 350 media outlets, and an advertisement for the public scoping meeting appeared in the following publications:

- *The Times-Picayune*, January 31, 2009 and February 7, 2009
- *The Baton Rouge Advocate*, January 31, 2009
- *The Houma Courier,* January 29, 2009 and February 9, 2009

The public scoping meeting was held on:

Tuesday, February 10, 2009
Houma Municipal Auditorium
880 Verrett St.
Houma, LA 70360

The schedule for the scoping meeting was:

6:00 – 7:00 p.m.	Open House
7:00 – 7:30 p.m.	Presentations
7:30 – 8:00 p.m.	Question and Answer Session
8:00 – 8:50 p.m.	Open Forum for Comments
8:50 – 9:00 p.m.	Wrap-up

The open house session provided attendees with an opportunity to visit a series of poster stations staffed by project team members and subject matter experts regarding the following topics:

- LCA plan
- NEPA process and milestones
- Overview of the study and its goals and objectives
- Maps of the Study Area

Following the open house, there was a brief presentation on the LCA TBBSR Study planned for the area and a description of the NEPA process. During this segment, the LCA Environmental Manager and both the USACE Project Managers and the Coastal Protection and Restoration Authority presented introductory remarks, including the agenda, purpose of the meeting, public involvement under NEPA, a brief history leading to the study, the scope of the analysis, and the intent to prepare a Final EIS for the LCA TBBSR Study.

The question and answer portion focused on explaining the study process and responding to general questions presented by meeting attendees. Following this portion, the floor was opened for scoping comments. Individuals were invited to present their verbal and/or written scoping comments to be recorded without interruption. This portion of the meeting continued until no further scoping comments were offered.

During the wrap-up, attendees were reminded to pick up self mailing comment cards if they wished to submit additional comments at a later date, and to drop off the meeting evaluation forms at the registration table.

6.2 Scoping Comments

Scoping and public comments document the public's concerns about the scope of the proposed course of action and identify significant resources and suggested alternatives. Scoping comments will be considered during the study process and in preparation of the SEIS. A total of 45 participants signed in for the scoping meeting in Houma, Louisiana.

A total of 22 multi-part comments were received during the comment period. Nine individuals expressed comments at the Houma scoping meeting. A total of 13 written comments were received during the comment period. There were two scoping comment cards, five scoping comment letters and six scoping comment e-mails. There were no scoping comments submitted via the Web site for this study.

A scoping comment may contain several specific comments directed at multiple areas of concern. Hence, a single comment could potentially be addressed in multiple sections of the SEIS. A total of 74 specific comments were expressed.

The comments were categorized according to their applicability to the SEIS. SEIS categories include:

- Purpose and Need
- Alternatives
- Affected Environment
- Environmental Consequences
- Consultation, Coordination, and Compliance with Regulations

An individual scoping comment may be categorized under more than one SEIS subject matter heading, but no one comment was assigned to more than three categories.

Purpose and Need

The majority of comments received in this category stressed the need to protect the barrier islands in the area: "*Our barrier islands are our first line of defense both for storm surge protection and protection of the estuaries. This is the first study that focuses strictly on our barrier island chain from Belle Pass westward over for the Terrebonne and Lafourche or Lafourche Basin barrier island chain and everybody wants this project"* (USACE, 2009). Several respondents stressed the urgency of project implementation.

Alternatives

Using Ship Shoal sand and/or rock material in the restoration efforts was the most common suggestion, closely followed by reducing the width of the passes. "*We are a proponent of using rock protection to the greatest extent possible, marsh creation and reduction in the width of the passes*." Concerns regarding cost of Ship Shoal sand were raised "*Regarding the use of Ship Shoal sand, I've heard it's the best in southern Louisiana. It would be great to use it, but we probably shouldn't wait until we can afford Ship Shoal sand. We might be better off mining sand on the back bays, Timbalier Bay and Lake Pelto, as we've done in the past*" (USACE, 2009).

Affected Environment

The most common concern raised regarding affected environment was the need to include Wine Island in the restoration effort *"Wine Island, which is now submerged slightly, is not part of your project. That 6-mile gap is significant and should be part of the project*." Another commonly raised suggestion was to narrow passages to lower water velocity "*Environmentally we would be better off with narrow passes and deeper passes, short of doing anything to the north. Because the Barataria Pass next to Grand Isle, we have maintained the width. Now it is probably 70 or 80 ft deep right at the pass, because there's a lot of volume of water that goes in and out from the Barataria Basin. The passes from Belle Pass eastward are choked down by rocks*" (USACE, 2009).

Environmental Consequences

Few comments could be exclusively classified as relating to environmental consequences, but several concerns were raised regarding the issue of saltwater intrusion. "*The St. Louis Canal should not have been dammed. We no longer get fresh water from the Intracoastal Waterway to flush salt water south, out of Hope Farm and Point-Aux-Chenes"* (USACE, 2009)

Consultation, Coordination, and Compliance with Regulations

Concerns regarding urgency of project implementation dominated the comments received. "*We ask that this project be addressed with the greatest sense of urgency due to the importance of hurricane protection and our disappearing wetlands"* (USACE, 2009). One commenter was worried this Study would be implemented too late.

6.2.1 Landowner Involvement

Louisiana Department of Wildlife and Fisheries (LDWF) currently own the Isle Dernieres Islands as well as the majority of Timbalier Island. LDWF has provided insight on the Study Area and participated fully in all public meetings.

6.2.2 Non-Governmental Organization (NGO) Involvement

Restore or Retreat (ROR) is a non-profit coastal advocacy group created by coastal Louisiana residents and stakeholders who recognize that the Barataria and Terrebonne basins are the two most rapidly eroding estuaries on earth, and that this erosion represents an economic and ecological crisis. ROR has attended the LCA Scoping meetings stakeholder meetings, and the CZM Meeting held December 2009 concerning Terrebonne Basin and has commented on the Study area and the opportunities that lie ahead.

6.2.3 Parish Involvement

Terrebonne Coastal Zone Management (CZM) was developed by Terrebonne Parish residents to protect, preserve, enhance, and where possible, restore renewable resources of the coastal wetlands for the enjoyment and long-term benefit of parish residents. Terrebonne Coastal Zone Management Committee (CZM) has attended the LCA Scoping meetings as well as a CZM Meeting in December 2009 concerning Terrebonne Basin and has commented on the Study area and the opportunities that lie within.

6.3 PUBLIC COMMENTS ON THE SUPPLEMENTAL EIS

The Supplemental EIS was released to the public in June 2010, and included a 45-day public review period. A public meeting soliciting comments on the proposed action presented in the SEIS was held during the public comment period. Comments from this review period have been incorporated into the final EIS. The final EIS was released for a 30-day public review period in October 2010.

7.0 COORDINATION AND COMPLIANCE

This chapter documents the coordination and compliance efforts for this Study regarding statutory authorities including: environmental laws, regulations, executive orders, policies, rules, and guidance. Consistency of the NER Plan and the first component of construction with other Louisiana coastal restoration efforts is also addressed. A summary of the Relevant Federal Statutory Authorities and Executive Orders is provided in Tables 7-1 and 7-2.

7.1 USACE Principles and Guidelines (P&G)

The guidance for conducting Civil Works planning studies (ER 1105-2-100) is based on the P&G adopted by the Water Resources Council. The P&G are composed of two parts: The Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies and the Economic and Environmental Guidelines for Water and Related Land Resources Implementation Studies. The P&G require the systematic formulation of alternative plans to ensure all reasonable alternatives are evaluated. The P&G also include guidance on the development and structure of the studies and reports for projects requiring specific authorization.

Under the study guidance for projects requiring specific authorization, the feasibility study requirements include documentation of the planning process and environmental compliance. The feasibility report is required to document the planning process and all assumptions made during plan formulation along with the rationale for decision making. The report should culminate in a recommended plan along with documentation of how the plan relates to the NED, NER Plan, or a combined NED/NER Plan. If the project deviates from those plans, the degree and reasons for the deviation must be documented. The feasibility study is also required to document compliance with applicable environmental laws and regulations which can be included as an Environmental Assessment (EA) or EIS included with the feasibility study or an integrated feasibility study document with NEPA information.

Planning for this feasibility study has been conducted in accordance with the ER 1105-2-100 guidance. This report is an integrated feasibility study and final EIS. Policy reviews have been conducted to ensure compliance with applicable USACE policies.

7.2 Environmental Coordination and Compliance

7.2.1 U.S. Fish and Wildlife Coordination Act

The USACE and the USFWS have formally committed to work together to conserve, protect, and restore fish and wildlife resources while ensuring environmental sustainability of our Nation's water resources under the January 22, 2003, Partnership Agreement for Water Resources and Fish and Wildlife. Accordingly, in a letter dated May 9, 2005, the USFWS indicated agreement to serve as a Cooperating Agency (per NEPA section 1501.6) in developing the final EIS for the proposed project in accordance with applicable NEPA and CEQ guidance. Participation of the USFWS includes: 1) participating in meetings and field trips to obtain baseline information on project-area fish and wildlife resources; 2) evaluating the proposed project's impacts to wetlands and associated fish and wildlife resources, and assisting in the development of measures to avoid, minimize, and/or compensate for those impacts; and 3) providing technical assistance in the development of a Biological Assessment describing the impacts of the proposed activity to Federally listed threatened or endangered species and/or their critical habitat.

Prior to the current Study, the USFWS partnered with various other State, local, and Federal agencies and entities in preparing the Programmatic Environmental Impact Statement (PEIS) on the LCA Comprehensive Coastwide Ecosystem Restoration Study. In a letter date September 26, 2003, the USFWS responded to a request by the Corps to provide the listed threatened and endangered species, their critical habitat, and migratory birds that may be found in or near the LCA TBBSR Study Area (LCA, 2004).

In a letter dated January 21, 2010, the USFWS provided specific guidance on including subtidal habitat in Study Area calculation. The letter also requested Barrier Island Wetland Value Assessment V1, V2, and V3 Values for all new alternatives that were added to the Final Array of Alternatives. Lastly, the letter notified the Corps that potential impacts to the threatened piping plover (Charadrius melodus) and/or its critical habitat via dredged material placement on the islands should be addressed in planning studies and that formal consultation with USFWS would be necessary if the proposed project directly or indirectly affects the plover or its critical habitat. The coordination letter is included in Appendix A.

The USACE requested consultation with the USFWS on August 9, 2010. The request initiated the formal consultation processes that culminated in the issuance of a USFWS Biological Opinion (Annex A2) on September 23, 2010. The USACE has agreed to comply with the RPM and the terms and conditions outlined in the Biological Opinion and summarized in Sections 3.6.7.1 and 3.7.7.1.

On September 17, 2010, the USFWS issued the Final Fish and Wildlife Coordination Act Report for the LCA TBBSR Study (Appendix B). The final report contains a description of existing fish and wildlife resources in the Study Area, discusses future with-project (FWP) and future without-project (FWOP) habitat conditions, and identifies fish and wildlife-related impacts. The USFWS also provided 13 recommendations to improve the proposed restoration measures:

1. The Service, NMFS, and LDWF should be provided an opportunity to review and submit recommendations on future detailed planning reports and the draft plans and specifications on the Terrebonne Basin Barrier Shoreline Restoration Project addressed in this report.

2. Consultation should continue with the Service and NMFS on detailed contract specifications to avoid and minimize potential impacts to piping plover and their critical habitat, manatees, sea turtles, migratory birds, and essential fish habitat.

3. Avoid adverse impacts to nesting waterbird colonies through careful design project features and timing of construction. For colonies containing nesting gulls, terns, and/or black skimmers, all activity occurring within 650 feet of a rookery should be restricted to the non-nesting period (i.e., September 16 through April 1, exact dates may vary within this window depending on species present). For colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary within this window depending on species present). Prior to any such work, surveys should be conducted by qualified personnel during the colonial seabird nesting season to determine the presence and location of any such colonies. In addition, we recommend that on-site contract personnel be informed of the need to identify colonial nesting birds and their nests, and should avoid affecting them during the breeding season. Because of the extent of the proposed restoration we understand that it may not be feasible to conduct all construction related activities outside of pertinent nesting seasons. Should those activities overlap with colonial nesting waterbird nesting seasons further coordination with this office will be necessary.

4. To minimize disturbance to nesting colonies of brown pelicans, all activity occurring within 2,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 15 through March 31). Prior to construction activities, surveys should be conducted by qualified personnel during the brown pelican nesting season to determine the presence and location ofany such colonies. In addition, we recommend that on-site contract personnel be informed of the need to brown pelicans and their nests, and should avoid affecting them during the breeding season. Because of the extent of the proposed restoration we understand that it may not be feasible to conduct all construction related activities outside of pertinent nesting seasons. Should those activities overlap with the brown pelican nesting season further coordination with this office will be necessary.

5. In order to minimize adverse impacts to blue crabs, we recommend that efforts be made to prohibit the mining of Ship Shoal during annual periods of highest blue crab use (i.e., April through October).

6. If the proposed project has not been constructed within 1 year or if changes are made to the proposed project, the Corps should re-initiate Endangered Species Act consultation with the Service.

7. Portions of the proposed project are within the Isles Dernieres Barrier Islands Refuge. No activities should occur on that refuge without first obtaining a Special Use Permit from LDWF.

8. The newly created barrier island and back-barrier marsh, as well as the surrounding habitats that may be indirectly benefited by long-shore transport and sediment overwash, should be monitored over the project life for effectiveness and the results should be provided to all resource agencies. Development of those monitoring plans should be coordinated with all natural resource agencies. In addition, those monitoring plans should be consistent with the Barrier Island Comprehensive Monitoring requirements developed by the Office of Coastal Protection and Restoration under funding from LCA Science and Technology Program.

9. All dredge material containment features should be breached or degraded, if necessary to restore tidal connectivity, once the marsh creation/nourishment areas have at least 80% coverage of emergent vegetation.

10. The Service recommends that the Wine Island "Rock Ring" alternative be re-analyzed for potential inclusion in the NER plan, taking into account qualitative benefits associated with important foraging, nesting, and roosting areas for federal trust resources that are not incorporated into the IWR.

11. If authorized funding limits for this project are increased the Service recommends that the NER plan (with Wine Island design if feasible) be reconsidered as the potential future SP.

12. If additional dollars become available for constructing further increments of the NER plan, the Service recommends that the Corps fully coordinate with the natural resource agencies in prioritizing restoration of those islands contained within the NER plan that are not within the SP.

13. In addition, to the above recommendations, LDWF believes that hard structures (such as segmented breakwaters) should be reconsidered for inclusion in the proposed project if additional funding becomes available. It has been LDWF's experience that hard structures add considerable longevity to barrier island restoration projects, offering high value for their cost. Therefore, we recommend that the COE coordinate with pertinent natural resource agencies regarding the potential use of hard structures should additional project funding become available.

The USACE concurred with and adopted all recommendations provided by the USFWS with the exception of Recommendations No. 10 and 13. The Wine Island Rock Ring was evaluated and screened during the plan formulation process. According the results of the CE/ICA analysis, the rock ring was considerably less cost effective than the other alternatives. The fixed cost associated with pipeline installation and equipment mobilization/ demobilization could not be justified given the few AAHUs that would be created by the rock ring alternative.

Segmented breakwaters and other hard structures were evaluated for each island during the plan formulation process (see Section 3.2.3). With the exception of the terminal groin on Raccoon Island, the hard structures that were evaluated were eliminated from further consideration because they either did not meet the initial screening criteria (Section 3.2.3.1) or because they were not cost effective based on the CE/ICA analysis. Island-specific evaluations of the breakwaters and terminal groins are provided in Section 3.2.3.3.

7.2.2 Clean Water Act – Section 401

Section 401 of the Clean Water Act requires the certification of all federal licenses and permits in which there is a "discharge of fill material into navigable waters". The certification is used to determine whether an activity will impact established site specific water quality standards. Federal licenses and permits cannot be issued without a water quality certification. The most common federal license or permit requiring certification is the USACE 404 permit.

In August 2010, the USACE submitted an application for a Water Quality Certification to the Louisiana Department of Environmental Quality (DEQ) for the implementation of the NER Plan. The USACE received a response from DEQ on September 20, 2010 stating that the requirements for a Water Quality Certification had been met and that the placement of fill material would not violate water quality standards of Louisiana as provided for in LAC 33:IX Chapter 11. DEQ further stated that a Water Quality Certification has been issued to the USACE (number WQC 100824-03/A1 171484/CER 20100003) for the NER Plan. The Water Quality Certification letter is provided in Appendix D.

7.2.3 Clean Water Act – Section 404(b)(1)

The USACE is responsible for administering regulations under Section 404(b)(1) of the Clean Water Act. Potential project-related impacts subject to these regulations, such as the discharge of dredged material into shallow open water areas to create wetlands, and the placement of rock for shoreline protection, will been evaluated in compliance with Section 404(b)(1) of the Clean Water Act. The Section 404(b)(1) Water Quality Report is included in Appendix D.

Table 7.1 Relevant Federal Statutory Authorities and Executive Orders (Note: This list is not complete or exhaustive)

Abandoned Shipwreck Act of 1987
American Indian Religious Freedom Act of 1978
Anadromous Fish Conservation Act of 1965
Archaeological Resources Protection Act of 1979
Archaeological and Historical Preservation Act of 1974
Bald Eagle Protection Act of 1940
Clean Air Act of 1970
Clean Water Act of 1977
Coastal Barrier Improvement Act of 1990
Coastal Barrier Resources Act of 1982
Coastal Wetlands Planning, Protection, and Restoration Act of 1990
Coastal Zone Management Act of 1972
Coastal Zone Protection Act of 1996
Comprehensive Environmental Response, Compensation, and Liability Act of 1980
Consultation and Coordination with Indian Tribal Governments (EO 13175) of 2000
Deepwater Port Act of 1974
Emergency Planning and Community Right-to-Know Act of 1986
Emergency Wetlands Restoration Act of 1986
Endangered Species Act of 1973
Environmental Quality Improvement Act of 1970
Estuaries and Clean Waters Act of 2000
Estuary Protection Act of 1968
Estuary Restoration Act of 2000
Exotic Organisms (EO 11987) of 1977
Farmland Protection Policy Act of 1981
Federal Actions to Address Environmental Justice in Minority Populations & Low-Income Populations (EO 12898, 12948) of 1994, as amended
Federal Compliance with Pollution Control Standards (EO 12088) of 1978
Federal Emergency Management (EO 12148) of 1979
Federal Water Pollution Control Act of 1972
Federal Water Project Recreation Act of 1965
Fish and Wildlife Conservation Act of 1980
Fish and Wildlife Coordination Act of 1958
Flood Control Act of 1944
Floodplain Management (EO 11988) of 1977
Food Security Act of 1985
Greening of the Government Through Leadership in Environmental Management (EO 13148) of 2000
Historic Sites Act of 1935
Historical and Archaeological Data-Preservation Act of 1974
Indian Sacred Sites (EO 13007) of 1996
Invasive Species (EO 13112) of 1999
Land & Water Conservation Fund Act of 1965
Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended
Marine Mammal Protection Act of 1972
Marine Protected Areas (EO 13158) of 2000
Marine Protection, Research, and Sanctuaries Act of 1972
Migratory Bird Conservation Act of 1929
Migratory Bird Treaty Act of 1918
Migratory Bird Habitat Protection (EO 13186) of 2001
National Environmental Policy Act of 1969
National Historic Preservation Act of 1966
National Invasive Species Act of 1996
Native American Graves Protection and Repatriation Act of 1990
Neotropical Migratory Bird Conservation Act of 2000
Noise Control Act of 1972
Nonindigenous Aquatic Nuisance Prevention and Control Act of 1996
North American Wetlands Conservation Act of 1989
Oil Pollution Act of 1990
Outer Continental Shelf Lands Act of 1953
Pollution Prevention Act of 1990
Prime or Unique Farmlands, 1980 CEQ Memorandum
Protection and Enhancement of the Cultural Environment (EO 11593) of 1971
Protection and Enhancement of Environmental Quality (EO 11991) of 1977
Protection of Children from Environmental Health Risks and Safety Issues (EO 13045) of 1997
Protection of Cultural Property (EO 12555) of 1986
Protection of Wetlands (EO 11990) of 1977
Reclamation Projects Authorization and Adjustments Act of 1992
Recreational Fisheries (EO 12962) of 1995
Resource Conservation and Recovery Act of 1976
Responsibilities of Federal Agencies to Protect Migratory Birds (EO 13186) of 2001
Rivers and Harbors Acts of 1899, 1956
River and Harbor and Flood Control Act of 1970
Safe Drinking Water Act of 1974
Submerged Land Act of 1953
Sustainable Fisheries Act of 1996
Toxic Substances Control Act of 1976
Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646)
Water Resources Development Acts of 1976, 1986, 1990, 1992, and 2007
Water Resources Planning Act of 1965
Watershed Protection & Flood Prevention Act of 1954
Water Pollution Control Act Amendments of 1961
Wild and Scenic River Act of 1968
Wilderness Act of 1964

Table 7.2 Relevant State Statutory Authorities (Note: this list is not complete or exhaustive)

Air Control Act Archeological Treasury Act of 1974 Louisiana Coastal Resources Program Louisiana Natural and Scenic Rivers System Act	Louisiana Threatened and Endangered Species and Rare & Unique Habitats Protection of Cypress Trees Water Control Act

7.2.4 Section 122 of the Rivers and Harbors Act

Section 122 of the River and Harbor Flood Control Act of 1970 (PL 91-611) provides for economic, environmental and social assessments, and requires that the Chief promulgate guidelines designed to ensure that adverse economic, social and environmental effects have been fully considered in plan formulation. The following specific effects have been addressed in the Environmental Consequences section (Section 5.0):

- Air, noise, water pollution.
- Destruction/disruption of resources, aesthetic values, community cohesion, etc.
- Adverse employment effects, tax and property values.
- Displacement.
- Disruption of desirable community and regional growth.

7.2.5 Coastal Zone Management Act of 1972

Section 307 of the Coastal Zone Management Act (CZM) of 1972 (16 U.S.C. 1456(c)(1)(A)) directs Federal agencies proposing activities or development projects (including civil work activities), whether within or outside the coastal zone, must assure that those activities or projects are consistent, to the maximum extent practicable, with the approved State coastal zone management program. A Consistency Determination is included with this report (Appendix E) and was submitted to the Louisiana Department of Natural Resources (LDNR) for consistency review. Consistency concurrence was received on August 6, 2010. Implementation of the NER Plan and the first component of construction has been considered consistent, to the maximum extent practicable, with the approved Louisiana State coastal management program.

7.2.6 Endangered Species Act of 1973

Compliance with the ESA (7 U.S.C. 136; 16 U.S.C. 460 et seq.) has been coordinated with the USFWS and the NMFS for those species under their respective jurisdictions. The use of recommended primary activity exclusion zones and timing restrictions would be utilized, to the maximum extent practicable, to avoid project construction impacts to any threatened or endangered species or their critical habitat within the Study Area. The USACE will continue to closely coordinate and consult with the USFWS and the NMFS regarding threatened and endangered species under their jurisdiction that may be potentially impacted by the proposed action. Although the West Indian manatee and the Hawksbill, Kemp's ridley, Leatherback, Loggerhead, and Green sea turtles may be found in the Study Area, the only endangered species with a high potential for adverse impacts from the NER Plan and the first component of construction is the piping plover. Multi-project research is currently underway to determine the potential for diversion impacts to this species. Formal consultation on the piping plover has been conducted and the USFWS has issued a Biological Opinion (Annex A2). The USACE has agreed to comply with the RPM and the terms and conditions outlined in the Biological Opinion and summarized in Sections 3.6.7.1 and 3.7.7.1.

The analysis of potential impacts of the NER Plan on endangered species is described in Section 5.11 - Threatened and Endangered Species. A U.S. Fish and Wildlife Service Biological Assessment is included in Appendix A.

7.2.7 Magnuson-Stevens Fishery Conservation and Management Act of 1996; and the Magnuson-Stevens Act Reauthorization of 2006 (Essential Fish Habitat)

As directed by the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 104-297), the USACE has coordinated with the NMFS and that agency's experts on various marine organisms, as well as EFH (letter from NMFS, 2009). Via e-mail on January 13, 2010, the NMFS provided an updated essential fish habitat guide prepared by the NMFS Southeast Regional Office as well as a link to the 2004 EIS and the 2005 Generic Amendment to the Fishery Management Plans which replaces the previously provided 2006 NMFS guidance document.

The NMFS identified shrimp, red drum, reef fish, and stone crabs as species managed by the Gulf of Mexico Fishery Management Council that have Essential Fish Habitat (EFH) in the proposed action area. They also listed estuarine emergent wetlands, mud, sand and shell substrates, and estuarine and marine water column as primary categories of EFH in the proposed action area. The analysis of potential impacts of the NER Plan and the first component of construction on EFH is described in Section 5.10 Essential Fish Habitat. The NOAA Fisheries Service Coordination Letter will be included in Appendix C once it is received.

7.2.8 Clean Air Act – Air Quality Determination

Compliance with the Clean Air Act (42 U.S.C.A. §§7401) will be fully coordinated with the Air Quality Section of the LDEQ (see also Section 5.4 Air Quality). As required by *Louisiana Administrative Code*, Title 33 (LAC 33:III.1405 B), an air quality applicability determination will be made for the NER Plan and the first component of construction. This will include consideration of the proposed action for the category of general conformity, in accordance with the Louisiana General Conformity, State Implementation Plan (LDEQ, 1994). An air quality determination will be calculated, based upon direct and indirect air emissions. Generally, since no other indirect Federal action, such as licensing or subsequent actions would likely be required or related to the restoration construction actions, it is likely that indirect emissions, if they would occur, would be negligible. Therefore, the air applicability determination analysis will be based upon direct emission for estimated construction hours. Considering that total emissions for each work item separately (or even when all work items are summed) would not exceed the threshold limit applicable to Volatile Organic Compounds (VOC) for parishes where the most stringent requirement (50 tons per year in serious non-attainment parishes) is in effect (see General Conformity, State Implementation Plan, Section 1405 B.2), the VOC emissions for the proposed construction would be classified as *de minimus* and no further action would be required.

7.2.9 National Historic Preservation Act of 1966

Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. § 470f), as amended, requires Federal agencies to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings. Pursuant to 36 C.F.R. 800 of the regulations implementing Section 106 of the National Historic Preservation Act, a Federal agency shall consult with the State Historic Preservation Officer (SHPO) and any Federally recognized Indian tribe that attaches religious and cultural significance to such properties. Accordingly, USACE initiated consultation with the ACHP, SHPO and federally recognized Indian tribes in May 2009.

In accordance with ER 1105-2-100, Appendix C, paragraph C-4(d)(5)(d)(2), the USACE elected to fulfill its obligations under Section 106 of the National Historic Preservation Act of 1966, as amended, through the execution and implementation of a Programmatic Agreement. In consultation with the ACHP, Louisiana SHPO, Indian tribes, representatives of local governments, and other consulting parties, the USACE developed a Programmatic Agreement among the USACE, CPRA, SHPO, and ACHP, pursuant to 36 CFR § 800.14(b)(1), executed July 29, 2010. The Programmatic Agreement establishes the procedures for consultation, identification of historic properties, assessment and resolution of adverse effects, and is included in Appendix F.

7.2.10 Farmland Protection Policy Act (Prime and Unique Farmlands)

The purpose of the Farmland Protection Policy Act (7 U.S.C. 658) is to minimize the extent to which Federal programs contribute to the unnecessary and irreversible conversion of farmland to non-agricultural uses. There are no farmlands within the Study Area. Hence, there would be no unnecessary or irreversible conversion of farmland to non-agricultural uses.

7.2.11 Executive Order 13186 – Migratory Bird Habitat Protection

Executive Order 13186 proclaims the intent to support the conservation of previous migratory bird conventions by integrating bird conservation principles, measures, and practices into agency activities and by avoiding or minimizing, to the extent practicable, adverse impacts on migratory bird resources when conducting agency actions. This Executive Order requires environmental analyses of Federal actions required by the NEPA or other established environmental review processes evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern. In addition, each Federal agency shall restore and enhance the habitat of migratory birds, as practicable. Implementation of the NER Plan and the first component of construction would result in a net increase in migratory bird habitat.

7.2.12 Executive Order 12898 – Environmental Justice

Concern with environmental justice issues can be traced to Title VI, Section 601 of the Civil Rights Act of 1964 (Public Law 88-352):

> *"No person in the United States shall, on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance."*

On February 11, 1994, President Clinton issued Executive Order 12898 regarding Federal actions to address environmental justice issues in minority populations and low-income populations:

> *"To the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the*

Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands."

Executive Order 12898 is designed to focus Federal attention on the environmental and human health conditions in minority communities and low-income communities. The order is also intended to promote non discrimination in Federal programs substantially affecting human health and the environment, and to provide minority communities and low income communities access to public information on, and an opportunity for public participation in, matters relating to human health or environmental planning, regulations, and enforcement. Potential environmental justice issues have been considered throughout the entire study process, and will continue to be considered through project implementation. As part of the NEPA process, a scoping input request was provided to the public and interested parties. The four scoping comments did not identify any potential environmental justice issues. The USACE is committed to ensuring that any potential environmental justice issues are addressed as the study proceeds. The proposed wetland creation and nourishment and shoreline protection measures would equally impact all potential users (e.g., commercial and recreational fishers) in the area. There would be no potential environmental justice issues from implementing the NER Plan or the first component of construction.

7.2.13 Executive Order 13112 – Invasive Species

On February 3, 1999, President Clinton issued Executive Order 13112 to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause by establishing the National Invasive Species Council. The NER Plan and the first component of construction are consistent with Executive Order 13112 to the extent practicable and permitted by law and subject to the availability of appropriations, and within Administration budgetary limits. The NER Plan and the first component of construction will use relevant programs and authorities to prevent the introduction of invasive species and not authorize, fund, or carry out actions likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere, unless the USACE has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species, and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions. The analysis of potential impacts of the NER Plan and the first component of construction on invasive species is described in Section 5.6.5 -Invasive Species – Vegetation.

7.2.14 Executive Order 11988 – Floodplain Management

Executive Order 11988 entitled "Floodplain Management" dated May 24, 1977, requires Federal agencies to evaluate the potential effects of actions it may take in a floodplain to avoid adversely impacting floodplains wherever possible, to ensure that its planning programs and budget requests reflect consideration of flood hazards and floodplain management, including the restoration and preservation of such land areas as natural undeveloped floodplains, and to prescribe procedures to implement the policies and procedures of this Executive Order. Guidance for implementation of the Executive Order has been provided by the U.S. Water Resources Council in its Floodplain Management Guidelines dated February 10, 1978 (see 40 FR 6030). The Floodplain / Wetland Public Notice and Statement of Findings will be included in Appendix G.

7.2.15 Executive Order 11990 – Protection of Wetlands

Executive Order 11990 entitled "Protection of Wetlands", dated May 24, 1977, requires Federal agencies to take action to avoid adversely impacting wetlands wherever possible, to minimize wetlands destruction and to preserve the values of wetlands, and to prescribe procedures to implement the policies and procedures of this Executive Order. The analysis of potential impacts of the NER Plan and the first component of construction on wetlands is described in Section 5.6.2.

7.2.16 Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970

All real estate interests acquired for construction of the NER Plan and the first component of construction will be in accordance with the provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Uniform Act), as amended in 42 USC 4601-4655, and the Uniform Regulations contained in 49 C.F.R. Part 24. The Uniform Act sets forth procedures for the acquisition of private property for public use and specifically requires that the acquiring agency appraise the real property interests it wishes to acquire and provide the owner a written summary of the basis for the amount established as just compensation.

7.2.17 Louisiana State Rare, Threatened, and Endangered Species, and Natural Communities Coordination

On February 3, 1999, Executive Order 13112 was signed to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause by establishing the National Invasive Species Council. The Executive Order requires that a Council of Departments dealing with invasive species be created. Currently there are 10 departments and agencies on the Council of Departments.

The NER Plan and the first component of construction is consistent with Executive Order 13112 to the extent practicable and permitted by law and subject to the availability of appropriations, and within Administration budgetary limits. The NER Plan and the first component of construction will use relevant programs and authorities to prevent the introduction of invasive species and not authorize, fund, or carry out actions likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless the USACE has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions. The analysis of potential impacts of the NER Plan and the first component of construction on EFH is described in Section 5.11 - Threatened and Endangered Species.

7.2.18 Coastal Barrier Resources Act of 1982

The Coastal Barrier Resources Act (CBRA) was passed in 1982 in an effort to discourage development on certain barrier islands and thereby minimize (1) loss of human life and property from storms, (2) wasteful Federal expenditures, and (3) damage to fish, wildlife, and other natural resources. This act prohibits most new Federal financial assistance such as national flood insurance for projects within the designated Coastal Barrier Resources System. The CBRA designated various undeveloped coastal barrier islands, which were illustrated by a set of maps adopted by law, to be included in the John H. Chafee Coastal Barrier Resources System (CBRS). According to boundary maps prepared by the USFWS, the Study Area is included in the John H. Chafee Coastal Barrier Resources System. Compliance with the CBRA will be coordinated with the USFWS who is the primary authority for implementation of the CBRA.

8.0 CONCLUSIONS AND DETERMINATIONS

8.1 AREAS OF CONTROVERSY AND UNRESOLVED ISSUES

An area of controversy that exists is the effectiveness of hardened structures, most notably, rock breakwaters and revetments, in achieving the Study goals. As previously described in the report, hard structures that have been used in the past on East Timbalier Island and Raccoon Island have had mixed results. The construction of jetties at Belle Pass and the seawall-groin systems along East Timbalier have been linked to the present erosion problems on East Timbalier, whereas, the segmented rock breakwaters on Raccoon have had positive results to date.

A concurrent resolution, sponsored by Representative Gordon Dove of Terrebonne Parish, was passed during the 2006 Regular Session of the Louisiana Legislature which prompted the United States Congress to ensure that any USACE projects designed to restore the barrier islands protecting Terrebonne and Timbalier Bays utilize hardened material to redefine and narrow Whiskey Pass, Wine Island Pass, and Cat Island pass. During the public scoping meeting held in March 2009, Terrebonne Parish President Mr. Michel Claudet and other members of the public stressed that rocks should be given proper consideration in light of the positive benefits demonstrated at Raccoon Island.

The Louisiana Department of Wildlife and Fisheries (LDWF) have also been very supportive of the use of hard structures on Raccoon and Whiskey Islands. Both of these islands are owned and managed by LDWF.

The PDT evaluated the use of segmented breakwaters on Whiskey Island and segmented breakwaters and a terminal groin on Raccoon Island using the GENESIS Model. Model results indicated that the breakwaters reduced erosion on Whiskey Island and Raccoon Island by 5.62 ft/year and 0.80 ft/year respectively. However, further analysis revealed that barrier island restoration using dredged material was a more cost-effective method of maximizing habitat created over the 50-year period of analysis.

The GENESIS model indicated that the terminal groin on Raccoon Island would result in accretion of sand on the western end of Raccoon Island and would yield cost-effective net benefits over 50-year period of analysis. The Raccoon Island terminal groin has been included in the NER Plan.

Due to the highly variable nature of the coastal processes within the Terrebonne Basin and the limitations of modeling barrier island restoration performance and response to structures with the GENESIS model as noted in Appendix L, it is recommended that combined wave and current modeling be conducted in PED on a system-wide level to support the NER Plan.

Because the neither the NER Plan nor first component of construction stop the problems that cause coastal erosion, there is concern that the plans are not sustainable. The island will begin to erode soon after construction, unable to maintain a stable level of benefits. The plan keeps intact the geomorphic and hydrologic structure and function of a barrier island throughout the period of analysis, providing benefits, albeit on a declining scale. The diminishing benefits are accounted for in the WVA benefits analysis.

The impacts of the Deepwater Horizon oil spill on coastal Louisiana are uncertain at this time (October 2010). The impacts of the oil spill as well as the various emergency actions taken to address oil spill impacts (e.g., use of oil dispersants, creation of sand berms, use of Hesco baskets, rip-rap, sheet piling and other actions) could potentially impact USACE water resources projects and studies within the Louisiana coastal area, including the LCA TBBSR Study. Potential impacts could include factors such as changes to existing, Future Without, and Future With Project conditions, as well as increased project costs and implementation delays. The USACE will continue to monitor and closely coordinate with other Federal and State resource agencies and local sponsors in determining how to best address any potential problems associated with the oil spill that may adversely impact project implementation. Supplemental planning and environmental documentation may be required as information becomes available. If at any time petroleum or crude oil is discovered on project lands, all efforts will be taken to seek clean up by the responsible parties, pursuant to the Oil Pollution Act of 1990 (33 U.S.C. 2701 et seq.).

Ongoing documentation of the impacts associated with the Deepwater Horizon Oil spill can be found in several governmental sources. The USFWS Situation Report for August 2, 21010 (http://www.fws.gov/home/dhoilspill/pdfs/MondayAugust22010.pdf) indicates the following environmental-related Deepwater Horizon oil spill information: 563 personnel are actively engaged in the response, working to protect wildlife and their habitats, including 36 national wildlife refuges. They are also assessing the damage from the oil spill in preparation for the work that will be needed to restore the Gulf of Mexico. Some 1,643 visibly oiled birds have been collected alive by the USFWS and our partners in response to the Deepwater Horizon oil spill. Of those, 594 birds have been rehabilitated and released. Another 1,451 visibly oiled birds have been collected dead. Aerial operations over Louisiana observed an oil sheen covering 300 acres in the northeastern portion of Barataria Bay. A heavily oiled coastline covering about one-half mile was found at Bayou Chalond and heavy oil and tar balls were observed on landfall east of Point-Au-Fer and along Timbalier Island. Beached bird surveys were conducted in Texas, Louisiana, Mississippi, Alabama and Florida. Aerial missions are scheduled for Southwest Pass, Chandeleur Islands, Biloxi Marsh, Barataria Bay, Terrebonne, Marsh Islands, Atchafalaya Delta, Point-Au-Fer and Timbalier Bay.

- Overall number of personnel responding: approximately 30,100

- Total vessels responding: more than 4,500
- Total boom deployed: more than 2,155 miles
- Boom available: more than 856 miles
- Oily water recovered: more than 34.7 million gallons
- Estimated 11.14 million gallons of oil burned
- Estimated total of more than 1.84 million gallons of dispersant used including:
    - Estimated more than 1.07 million gallons surface dispersant used
    - Estimated more than 771,000 gallons of sub-sea dispersant used:
- Estimated approximately 632 miles of Gulf Coast shoreline is currently oiled—approximately 365 miles in Louisiana, 111 miles in Mississippi, 68 miles in Alabama, and 88 miles in Florida.

The USACE, New Orleans District Regulatory Branch has considered and responded to approximately 55 emergency permits related to the Deepwater Horizon oil spill (http://www.mvn.usace.army.mil/pao/mvnoilspill.asp). Of particular concern are the permitted activities proposed for the islands in the LCA TBBSR Study (Table 8-1).

Table 8-1. USACE New Orleans District Regulatory Branch Deepwater Horizon Emergency Permit Request

DA Number	Project Name	Applicant	Action	Date Received	Date Issued	Date Denied	Date Withdrawn
MVN-2010-01136-WJ	Deepwater Horizon Oil Spill- State of Louisiana- Create Sand Protection Berm-Isles Dernieres Chain, Terrebonne Ph.	La. OCPR	NOD-20	18-May-10		6-Jul-10	
MVN-2010-01151-WB	Deepwater Horizon Oil Spill - Terrebonne Parish Government, Trinity Island, sand bags	Terrebonne Ph Govt	NOD-20	24-May-10			4-Jun-10
MVN-2010-01267-WB	Deepwater Horizon Oil Spill - Terrebonne Parish Government, install sheetpile with tiebacks for Closure of Canal 19 on Timbalier Island	Terrebonne Ph Govt	NOD-20	4-Jun-10	4-Jun-10		
MVN-2010-01338-WJJ	Deepwater Horizon Oil Spill, Terrebonne Parish, Dredge and Place Fill to Create Embankment	Terrebonne Ph Govt	NOD-20	11-Jun-10			15-Jun-10
MVN-2010-01473-WB	Deepwater Horizon Oil Spill - BP - Emergency Authorization for Piling/Boom Installation at Raccourci Lake - Lafourche	BP America Production Co	NOD-20	22-Jun-10	24-Jun-10		
MVN-2010-01549-WJJ	Deepwater Horizon Oil Spill - Emergency Authorization to Fill Breaks along Twin Pipeline Canal Levee - Terrebonne, Lafourche	Terrebonne Ph Levee and Conservation District	NOD-20	29-Jun-10			7-Jul-10
MVN-2010-01554-WB	Deepwater Horizon Oil Spill - Emergency Authorization for Pilings and Booms at Wine Island & Raccoon Island in Terrebonne Parishes	La. Wildlife & Fisheries	NOD-20	30-Jun-10	1-Jul-10		

In addition, the State of Louisiana is permitted to dredge and fill to construct six sand berm reaches along the shoreline of the Chandeleur Islands/Breton National Wildlife Refuge westward to Baptiste Collette Bayou and along the seaward shoreline of Timbalier Island eastward to Sandy Pont. Material to construct the berms would be dredged from Ship Shoal, South Pelto, the Mississippi River Offshore Disposal Site, Pass a Loutre, St. Bernard Shoal and Hewes Point. Emergency permits have the following clause that provides for removing, relocating, or altering permitted structures if necessary and upon due notice from the Corps. The clause would pertain to future actions by the United States, such as proposed Louisiana Coastal Area restoration projects:

> *The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee shall be required upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.*

As is evident from the numerous ongoing actions, the dynamic nature of the impacts associated with the Deepwater Horizon oil spill will likely require additional consideration in the near future for USACE Civil Works projects.

8.2 CONCLUSIONS

Alternative 5 (Raccoon with Terminal Groin (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / and Timbalier (Plan E)) was selected as the NER Plan. The plan would add 3,283 acres of habitat (dune, intertidal, and supratidal) to the existing island footprints of Raccoon, Whiskey, Trinity, and Timbalier Islands, increasing the total size of the islands to 5,840 acres. This would result in the restoration and creation of approximately 472 acres of dune, 4,320 acres of supratidal habitat, and 1,048 acres of intertidal habitat. Renourishment events will occur at TY 30 for Raccoon Island Plan E and Timbalier Plan E, TY25 for Trinity Island Plan C, and TY20 and TY40 for Whiskey Island Plan C.

The barrier island restoration features of the NER Plan would achieve the planning objectives by maximizing the barrier island's ability to provide geomorphic and hydrologic form and ecological function over the 50-year period of analysis as well as improve critical barrier island habitats for fish, migratory birds, and other terrestrial and aquatic species. Sediment would be placed into the system to supplement longshore sediment transport processes along the gulf shoreline by mechanically introducing compatible sediment, and increasing the ability of the restored area to continue to function and provide habitat with minimum continuing intervention.

The NER Plan is the plan that best meets the goal of the 2004 LCA Plan to address critical near-term needs for shoreline restoration for Terrebonne Basin through simulating historical conditions by enlarging the barrier islands (width and dune crest) and reducing the current number of breaches to ensure the continuing geomorphic and ecological form and function of the barrier islands. The selection of the NER Plan was based on a thorough review of existing scientific and engineering reports, as well as geospatial, survey, and geotechnical data which reaffirmed that the findings of the Final Programmatic Environmental Impact Statement remained valid.

The NER Plan is also the plan that best meets the USACE Principles and Guidelines of completeness, effectiveness, efficiency, and acceptability, as well as the Environmental Operating Principles of environmental sustainability, interdependence, balance and synergy, accountability, knowledge, respect, and assessing and mitigating cumulative impacts.

However, the NER Plan cannot be constructed within WRDA 2007 authorization. Therefore Whiskey Island Plan C, a subset of the NER Plan was selected as the first component of construction. The plan will restore a total of 1,272 acres on the island, including 65 acres of dune, 830 acres of supratidal habitat, and 377 acres of intertidal habitat. The plan will be constructed on the existing island footprint, which consists of 377 acres of supratidal habitat and 443 acres of intertidal habitat at TY0. A renourishment event will be conducted at TY20 and at TY40 in order to maintain the geomorphic form and ecologic function of the island throughout the 50-year period of analysis. Whiskey Island Plan C is an implementable increment of the NER plan, meets the LCA Program and project objectives, and is within the cost and scope of the WRDA authorization.

8.3 Recommendations

The District Commander has considered all the significant aspects of this study including the environmental, social, and economic effects, engineering feasibility, and the comments received from the non-Federal sponsors, the public, and other resource agencies. Based on this information, the District Commander has determined that the NER Plan presented in this report is in the overall public interest and is a justified expenditure of Federal funds. Therefore, the District Commander recommends the NER Plan for implementation.

Alternative 5 (Raccoon with Terminal Groin (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / and Timbalier (Plan E)) was selected as the NER Plan because it is a Best Buy plan that fulfills the planning objectives in Section 2.3 of this report. The NER Plan would restore the geomorphologic form and ecologic function of the four islands in the Terrebonne Basin barrier system. Immediately after construction (TY1), the NER Plan would add 3,283 acres of habitat (dune, intertidal, and supratidal) to the existing island footprints of Raccoon, Whiskey, Trinity, and Timbalier Islands, increasing the total size of the islands to 5,840 acres. This would result in the restoration and creation of approximately 472 acres of dune, 4,320 acres of supratidal habitat, and 1,048 acres of intertidal habitat.

The creation of dune, supratidal, and intertidal habitats would provide essential habitats for fish, migratory birds, and other terrestrial and aquatic species. Furthermore, by using the proposed borrow areas, the NER Plan would increase sediment input to supplement longshore sediment transport processes along the gulf shoreline by mechanically introducing compatible sediment, and increasing the ability of the restored area to continue to function and provide habitat with minimum continuing intervention. Sediment placed on Trinity Island would eventually be transported to Whiskey Island and Raccoon Island as the sediment moves westward through the system. Raccoon Island would also receive sediment directly from Whiskey.

The NER Plan includes renourishment at staggered intervals for each island over the 50-year period of analysis. Renourishment events will occur at TY 30 for Raccoon Island Plan E and Timbalier Plan E, TY25 for Trinity Island Plan C, and TY20 and TY40 for Whiskey Island Plan C.

The NER Plan was also selected because it would protect existing critical habitat on Raccoon and Whiskey Islands. Raccoon Plan E and Whiskey Plan C were designed to avoid approximately 58 and 286 acres of existing mangroves on the islands, respectively, thereby minimizing potential adverse ecologic impacts during construction. Since these two islands are considered to be valuable wildlife habitats (Isles Dernieres Barrier Islands Wildlife Refuge) and the LDWF is reestablishing a pelican rookery on Whiskey Island, maintaining adequate areas of healthy beach, dune, and marsh is particularly important. Raccoon, Whiskey, Trinity, and Timbalier are also a critical habitat for endangered species including the piping plover and are a valuable stopover habitat for migratory birds.

In addition to protecting and maintaining ecological benefits, the NER Plan would supplement existing State investments on the island. For example, Whiskey Plan C was designed to complement TE-50, which is an existing CWPPRA project that was constructed in 2009. Raccoon Plan E was designed to complement two separate CWPPRA projects, TE-29 and TE-48.

The NER Plan meets the LCA program and project objectives and is within the scope of the authorization. However, it exceeds the authorized cost. The State of Louisiana, acting as the non-Federal sponsor, concurs with the District Commander's recommendation that additional Congressional authorization be requested to allow implementation of the NER plan to fully address the restoration needs of the Study Area identified in this report. The estimated total first cost of the NER plan is $646,931,000. The Federal share of the estimated first cost of this project is $420,505,000 and the non-Federal share is $226,426,000.

The District Commander recommends that the first component of construction (Whiskey Island Plan C) of the NER plan be implemented under the existing authority provided in Section 7006(e)(3) of WRDA 2007. Whiskey Island Plan C includes renourishment at TY20 and TY40 to maintain the constructed features. Restoration of the one island will increase habitat function by 678 AAHUs by restoring a total of 1,272 acres on the island, including 65 acres of dune, 830 acres of supratidal habitat, and 377 acres of intertidal habitat. Whiskey Island Plan C is an implementable increment of the NER plan, meets the LCA Program and project objectives, and is within the cost and scope of the WRDA authorization. The State of Louisiana, acting as the non-Federal sponsor, supports immediate implementation of Whiskey Island Plan C as the first component of construction. The estimated total first cost of the Whiskey Island Plan C is $113,434,000. The Federal share of the estimated first cost of this project is $73,732,000 and the non-Federal share is $39,702,000. Implementation requirements and responsibilities are discussed in Section 3.10.2.

9.0 DISTRIBUTION LIST AND OTHER

9.1 Distribution List

This Integrated Feasibility Report and Final EIS will be distributed to Federal, State, parish, and local agencies; tribes; businesses; libraries; museums; universities; environmental organizations, groups and individuals; and scoping participants. The complete distribution list will be available upon request from the USACE at the following address.

U.S. Army Corps of Engineers
New Orleans District
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9.2 List of Preparers

Many individuals were involved with the completion of this document. The following table lists those people who assisted in writing this Integrated Feasibility Study and Final EIS.

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9.3 Literature Cited

Abernethy, Y., and R.E. Turner. 1987. U.S.forested wetlands: 1940-1980. BioScience. 37: 721-727.

Baltz, DM., Rakocinsky, C., and Fleeger, JW. "Microhabitat use by marsh-edge fishes in a Louisiana estuary." Enviornmental Biology of Fishes. 36 (1993):109-26.

Barras, J. A., 2006, Land area change in coastal Louisiana after the 2005 hurricanes—a series of three maps: U.S. Geological Survey Open-File Report 06-1247

Barras, J.A., 2009, Land area change and overview of major hurricane impacts in coastal Louisiana, 2004-08: U.S. Geological Survey Scientific Investigations Map 3080, scale 1:250,000, 6 p. pamphlet.

Bellrose, F.C. 1980. Ducks, Geese and Swans of North America. Stackpole Books Inc. Harrisburg, PA. 562 pp. Ducks unlimited September/October 1998, pg.20

Birchett, Thomas and Charles E. Pearson 1998 Underwater Cultural Resources Survey of the Houma Navigation Canal, Cat Island,Pass, Pass Channel Realignment, Terrebonne Parish, Louisiana. Coastal Environments, Inc., Baton Rouge. Submitted to U.S. Army Corps of Engineers, New Orleans District. Contract No. DACW29-97-D-0017.

Bouchard, R. and N.J. Turner. 1976. Ethnobotany of the Squamish Indian People of British Columbia. Unpublished Manuscript. British Columbia Indian Language Project, Victoria, B.C.

Britton, J.C., and B. Morton. 1989. Shore ecology of the Gulf of Mexico. University of Texas Press, Austin, Texas. 387 pp.

C & C Technologies (C & C). 2003a. Whiskey Island West Flank Restoration Project Using Ship Shoal Sediment Coastal Terrebonne Parish, Louisiana: High Resolution Geophysical and Archaeological Survey of the Portions of Blocks 87, 88, 89, 94, and 95 Ship Shoal Area.

Coastal Engineering Consultants, Inc. and SJB Group, LLC. 2008. "Caminada Headland: Barataria Barrier Shoreline Restoration Feasibility Study - Appendix C". Report to Louisiana Department of Natural Resources, Baton Rouge, May 2008. LDNR Contract No. 2503-08-06.

Coastal Wetlands Planning, Protection, and Restoraiton Act (CWPPRA), 2002. "Wetland Value Assessment Methodology – Barrier Island Community Model", Prepared by: Environmental Work Group. August 2002.

Chabreck, R. H., T. Joanen, and S. L. Paulus. 1989. Southern coastal marshes and lakes. Pp. 249–277. In L.M. Smith, R.L. Pederson, and R.M. Kaminksi, (Eds.). Habitat Management for Migrating and Wintering Waterfowl in North America. Texas Tech University Press, Lubbock, TX. 574. pp.

Coastal Protection and Restoration Authority (CPRA), 2007. Integrated Ecosystem Restoration and Hurican Protection: Louisiana's Comprehensive Master Plan for as Sustainable Coast. http://www.lacpra.org/index.cfm?md=pagebuilder&tmp=home&nid=24&pnid=0&pid=28&fmid=0&catid=0&elid=0

Condrey, R. E. and C. G. Gelpi, 2010. "Blue Crab (*Callinectes sapidus*) use of the Ship/Trinity/Tiger Shoal Complex as a Nationally Important Spawning/Hatching/ Foraging Ground: Discovery, Evaluation, and Sand Mining Recommendations Based on Blue Crab, Shrimp, and Spotted Seatrout Findings." U.S. Department of the Interior, Mineral Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2009-043. 42pp.

Condrey, R., P. Kemp, J. Visser, J. Gosselink, D. Lindstedt, E. Melancon, G. Peterson, and B. Thompson. 1995. Status, trends, and probable causes of change in living resources in the Terrebonne Estuarine Systems. BTNEP Publication No. 21. Barataria-Terrebonne National Estuary Program, Thibodaux, Louisiana. 434 pp.

Conner, W. H. and J. W. Day. 1987. The ecology of Barataria Basin, Louisiana: an estuarine profile. Fish and Wildlife Service. Biological Report 85(7.13). July 1987. 166 pp.

Davis, R.W., Ortega-Ortiz, J.G., Ribic, C.A., Evans, W.E., Biggs, D.C., Ressler, P.H., Cady, R.B., Leben, R.R., Mullin, K.D., Würsig, B. 2002. "Cetacean habitat in the northern oceanic Gulf of Mexico". Deep-Sea Res. I 49:121-142.

Day, JW., and Templet, PH. "Consequenses of Sea-level rise- Implications from the Mississippi Delta." Coastal Management 17 (1989): 241-57.

Delane, RD., Smith, CJ., Patrick, WH., and Roberts, HH. “Rejuvenated Marsh and bay-bottom accretion on the rapidly subsiding coastal-plain of United-States Gulf-Coast - A 2nd -order effect of the emerging Atchafalaya Delta.” Estuarine Coastal and Shelf Science 25 (1987): 381-9

Ferland, C.L. and S.M. Haig. 2002. “2001 International Piping Plover Census”. U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Corvallis, Oregon. 293 pp.

Finkl, C. W., Andrews J. L, Benedet L., and Campbell T. 2005. “Geotechnical Investigation for Exploration of Sand Resources in the Lower Mississippi River and South Pass, and Exploration for Sand via Vibracoring in South Pelto Blocks 12 & 13”. Boca Raton, Florida. Coastal Planning & Engineering, Inc. 40p. (Report Prepared for the Louisiana Department of Natural Resources, Baton Rouge, Louisiana).

Gagliano, SM., Meyerarendt, KJ., and Wicker, KM. “Land loss in Mississippi River Deltaic Plain.” AAPG Bulletin- American Association of Petroleum Geologists 65 (1981): 1684-5.

Georgiou, I.Y., Fitzgerald, D.M., and Stone, G.W., 2005. The Impact of Physical Processes along the Louisiana Coast. Journal of Coastal Research, SI(44), 72–89. West Palm Beach (Florida), ISSN 0749-0208.

Gibbons, M.J. et al. 1999. The taxonomic richness of South Africa’s marine fauna: a crisis at hand. South African Journal of Science 95:8-12.

Gillespie, M.C. 1971. Analysis and Treatment of Zooplankton of Estuarine Waters of Louisiana. In: W.S. Perret, et al. Cooperative Gulf of Mexico Estuarine Inventory and Study, Louisiana. Phase I, Area Description, and Phase IV, Biology, p. 107-175. La. Wildl. Fish. Comm.

Gillespie, M.C. 1978. Zooplankton Analysis. In: B.B. Barrett, J.L. Merrell, T.P. Morrison, M.C. Gillespie, E.J. Ralph, and J.F. Burdon, eds., A Study of Louisiana’s Major Estuaries and Adjacent Offshore Waters. La. Dept. Wildl. Fish. Tech. Bull. 21:21-80.

Goodwin & Associates, Inc. 2008. Raccoon Island Shoreline Protection/Marsh Creation (TE-48) Submerged Cultural Resources Investigations.

Helmers, D.L. 1992. Shorebird management manual. Western Hemisphere Shorebird Reserve Network, Manomet, Maine. 58 pp.

Intergovernmental Panel on Climate Change (IPCC) 2007. Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. (Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and H. L.Miller, eds.).Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. http://ipcc-wg1.ucar.edu/wg1/wg1-report.html

Kelley, D., Pearson C. E., James S. R., and Ryan J., 2009. Phase I Cultural Resources Survey of Areas to be Affected by the Houma Navigation Canal Deepening Project, Terrebonne Parish, Louisiana. Prepared for U.S. Army Corps of Engineers, New Orleans District. R. Christopher Goodwin & Associates, Inc. Frederick, Maryland.

Khalil, S., Knotts, C, Tate, B. 2006. "Restoration of Louisiana Barrier Islands: Engineering Approaches to Hazard Mitigation by Modulating Coastal Environments". ICCE, 2006.

Khalil, S., Finkl, C., Andrews, J., Knotts, C. 2007. "Restoration-Quality Sand from Ship Shoal, Louisiana: Geotechnical Investigation for Sand on a Drowned Barrier Island". ASCE, Coastal Sediments, 2007.

Khalil, S., Finkl, C, Roberts, H., and Raynie, R., 2010. New Approaches to Sediment Mangement on the Inner Continental Shelf Offshore Coastal Louisiana, Under publication.

Kindinger, J., Flocks, J., Kulp, M., Penland, S., and Britsch, L.D. 2001. "Sand Resources, Regional Geology, and Coastal Processes for the Restoration of the Barataria Barrier Shoreline". Report to U.S. Army Corps of Engineers, New Orleans District, September 2001. US Geological Survey Open File Report 01-384.

Kindinger, J., Flocks, J., Kulp, M., Penland, S. 2002. "Regional Geology, Coastal Processes, and Sand Resources in the Vicinity of East Timbalier Island". Report to Louisiana Department of Natural Resources, Baton Rouge, August 2002.

Knox. G.A. 2001. The ecology of seashores. CRC Press LLC, Boca Rotan, Florida. 557 pp.

Kulp, M., Penland, S., and Ramsey, K. 2001. "Ship Shoal: Sand Resource Synthesis Report". Coastal Research Laboratory, Department of Geology and Geophysics, University of New Orleans, New Orleans, LA, prepared for Lee Wilson and Associates, July 2001.

Kulp, M., Pennland, S., Williams, SJ., Jenkins, C., Flocks, J., and Kindinger, J. "Geologic framework, evolution, and sediment resources for restoration of the Louisiana coastal zone." Journal of Coastal Research Sp.Iss. 44 (2005):56-71.

Laiche, G. 1993. The status of oyster leases and leasing practices. In Breton Sound. Louisiana Department of Wildlife and Fisheries. Unpublished.

Lee, D. and Syed Khalil. 2007. Unpublished report prepared for presentation at the Houma Navigation Canal deepening HET meeting on July 24, 2007. Louisiana Department of Natural Resources, Baton Rouge, Louisiana.

Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority. 1999. Coast 2050: Toward a Sustainable Coastal Louisiana, the Appendices. Appendix E—Region 4 supplemental information. Louisiana Department of Natural Resources. Baton Rouge, Louisiana. 173 pp.

Louisiana Coastal Wetlands Conservation and Restoration Task Force. 2006. Louisiana Coastal Wetlands Planning, Protection and Restoration News: The Paradox of Plenty – Does Today's Bounty Herald Tomorrow's Collapse. Louisiana Coastal Wetlands Planning, Protection and Restoration News. June 2006, Number 31.

Louisiana Department of Environmental Quality. 2002. Water Quality Integrated Report (305(b)/303(d)) – 2002 Water Quality Inventory. Louisiana Department of Environmental Quality. Baton Rouge, Louisiana.

Louisiana Department of Environmental Quality. 2005. 2004 Water Quality Integrated Report. Louisiana Department of Environmental Quality, Water Quality Assessment Diverion, Water Quality Inventory Section 305(b). Baton Rouge, Louisiana.

Louisiana Department of Natural Resources (LDN), 1989. Coast 2050: Toward a sustainable coastal Louisiana. Louisiana Department of Natural Resources. Baton Rouge. Louisiana. 161 pp.

Louisiana Department of Natural Resources. 1999. "Monitoring Progress Report for Raccoon Island Breakwaters Demonstration (TE-29)". Coastal Restoration Division, Baton Rouge, Louisiana.

Louisiana Department of Natural Resources. 2004. "2004 Operations, Maintenance, and Monitoring Report for Whiskey Island Restoration (TE-27)". Coastal Restoration and Engineering Divisions, Thibodaux, Louisiana.

Louisiana Department of Natural Resources. 2005a. "Final Design Report, Ship Shoal -Whiskey Island West Flank Restoration (TE-47)". Coastal Engineering Division, Baton Rouge, Louisiana. Prepared by DMJM Harris, Inc. December 30, 2005.

Louisiana Department of Natural Resources. 2005b. "Project Completion Report, Timbalier Island Dune/Marsh Restoration Project (TE-40)". Coastal Engineering Division, Baton Rouge, Louisiana.

Louisiana Department of Natural Resources. 2006a. "Comprehensive Monitoring Report No. 1 for Timbalier Island Plantings Demonstration (TE-18)". Coastal Restoration Division, Baton Rouge, Louisiana.

Louisiana Department of Natural Resources. 2006b. Timbalier Island Dune and Marsh Restoration (TE-40) General Fact Sheet. URL: http://dnr.louisiana.gov/crm/coastres/project.asp?id=TE-40.

Louisiana Department of Natural Resources. 2006c. "Project Completion Report, Timbalier Island Dune/Marsh Restoration Project (TE-40), Sand Fencing". Coastal Engineering Division, Thibodaux, Louisiana.

Louisiana Department of Natural Resources. 2007a. "2004 Operations, Maintenance, and Monitoring Report for Isle Dernieres Restoration East Island (TE-20)". Coastal Restoration and Engineering Divisions, Thibodaux, Louisiana.

Louisiana Department of Natural Resources. 2007b. "2004 Operations, Maintenance, and Monitoring Report for Isle Dernieres Restoration East Island (TE-20)". Coastal Restoration and Engineering Divisions, Thibodaux, Louisiana.

Louisiana Department of Natural Resources. 2007c. New Cut Dune and Marsh Restoration (TE-37) General Fact Sheet. URL: http://dnr.louisiana.gov/crm/coastres/project.asp?id=TE-37.

Louisiana Department of Natural Resources. 2008a. The Strategic Online Natural Resources Information System SONRIS), (http://sonris.www.dnr.state.la.us/www_root/sonris_portal_1.htm), Coastal Use Permit Data. 12 June Baton Rouge, Louisiana 70804-4027 USA.

Louisiana Department of Natural Resources. 2008b. The Office of Coastal Restoration and Management Website. Coastal Impact Assistance Program (CIAP), Project Proposals. (http://dnr.louisiana.gov/crm/ciap/project-proposals/Region3/Terrebonne/3II-T.%20Raccoon%20BW.pdf), 04 August 2008. Raccoon Island Breakwaters. Baton Rouge, Louisiana.

Louisiana Department of Natural Resources. 2008c. The Office of Coastal Restoration and Management Website. Coastal Impact Assistance Program (CIAP), Project Proposals. (http://dnr.louisiana.gov/crm/ciap/project-proposals/Region3/Terrebonne/3NN-T/#NN-TE.%20Timbalier%20fact%20sht.pdf), 04 August 2008. East Timbalier Island Sediment Restoration. Baton Rouge, Louisiana.

Louisiana Department of Natural Resources. 2008e. The Office of Coastal Restoration and Management Website. Coastal Impact Assistance Program (CIAP), Project Proposals. (http://dnr.louisiana.gov/crm/ciap/project-proposals/Region3/Terrebonne/Offical/3I-T.%20E%20Trinity%20Isl%20beach%20back%20barrier%20marsh%20rest.pdf), 04 August 2008. Beach and Back Barrier Marsh Restoration, East and Trinity Islands. Baton Rouge, Louisiana.

Louisiana Department of Natural Resources. 2008f. The Office of Coastal Restoration and Management Website. Coastal Impact Assistance Program (CIAP), Project Proposals. (http://dnr.louisiana.gov/crm/ciap/project-proposals/Region3/Terrebonne/3EE-T.%20wine%20island%20restoration.pdf), 04 August 2008. Wine Island Restoration. Baton Rouge, Louisiana.

Louisiana Department of Natural Resources. 2008g. The Office of Coastal Restoration and Management Website. Coastal Impact Assistance Program (CIAP), Project Proposals. (http://dnr.louisiana.gov/crm/ciap/project-proposals/Region3/Terrebonne/3PP-T.%20East%20Island%20Shoreline%20Restoration.pdf), 04 August 2008. East Island Breach Dune & Marsh Restoration Project. Baton Rouge, Louisiana.

Louisiana Department of Natural Resources. 2009. SONRIS Database. http://sonris-www.dnr.state.la.us/www_root/sonris_portal_1.htm

Louisiana Department of Natural Resources and United States Environmental Protection Agency. 2007. "Final Report Hydrographic, Geophysical and Geotechnical Survey Program Whiskey Island Back Barrier Marsh Creation (TE-50), OSI Project # 06ES003". Coastal Engineering Division, Baton Rouge, Louisiana.

Louisiana Department of Wildlife and Fisheries. 2008. Louisiana Bird Colony Survey: Isle Dernieres. Louisiana Department of Wildlife and Fisheries. Baton Rouge, Louisiana.

Louisiana Department of Wildlife and Fisheries. 2008c. Louisiana Department of Wildlife and Fisheries: 2006-2007 Annual Report. Louisiana Department of Wildlife and Fisheries. Baton Rouge, Louisiana.

Louisiana Department of Wildlife and Fisheries. 2008d. The Economic Benefits of Fisheries, Wildlife and Boating Resources in the State of Louisiana – 2006. Louisiana Department of Wildlife and Fisheries. Baton Rouge, Louisiana.

Louisiana Geographic Information Center (LAGIC), and U.S. Department of Commerce, U.S. Census Bureau, Geography Division. 2007. TIGER/Line, Census Places (points) of Louisiana, Geographic NAD83, LAGIC. Baton Rouge, Louisiana.

Louisiana Geological Survey (LGS), 1995. "The Coastal Sand Dunes of Louisiana – An Inventor; The Bayou Lafourche Barrier Shoreline". Coastal Geology Technical Report No. 9. 1995.

Louisiana Oil Spill Coordinator's Office (LOSCO). 1999. Navigated Waterways of Louisiana, Geographic NAD83, LOSCO (1999) [navigated_waterways_LOSCO_1999].

Lowery, G. H., Jr. 1974. Louisiana Birds. Revised 3rd edition. Louisiana State Univ. Press. 651 pp. -- includes account of the first record for the Goshawk in Louisiana, which was banded at Hawk Ridge.

Martin, R.P., and G.D. Lester. 1991. Atlas and census of wading bird and seabird nesting colonies in Louisiana: 1990. Louisiana Department of Wildlife and Fisheries, Louisiana Natural Heritage Program. Special Publication No.3. 182 pp.

Mac, M. J., P. A. Opler, C. E. Puckett Haecker, and P. D. Doran. 1998. Status and trends of the nation's biological resources. Vol. 2. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va. 437-964 pp.

Michel, J. 2004. "Regional Management Strategies for Federal Offshore Borrow Areas, U.S. East and Gulf of Mexico Coasts." Journal of Coastal Research, vol. 20, no. 1: 149-154.

Mitsch, W.J. and J.G. Gosselink. 1993. Wetlands. 2nd Ed. Van Nostrand Reinhold, New York, USA. 722pp.

Moore, F.R., P. Kerlinger, AND T. R. Simons. 1990. Stopover on a Gulf coast barrier island by spring trans-Gulf migrants. Wilson Bull. 102:487-500.

National Marine Fisheries Service. 2008. Fisheries of the United States 2007. National Marine Fisheries Service Office of Science and Technology, Fisheries Statistics Division. Silver Spring, Maryland. Current Fishery Statistics No. 2007. 100 pp.

Nairn, R., Langendyk, S., and Michel, J. 2004. "Preliminary Infrastructure Stability Study, Offshore Louisiana." Prepared by Baird & Associates and Research Planning, Inc. Submitted to U.S. Department of the Interior, Minerals Management Service. Contract No. 35-001-31051.

National Audubon Society, 2010. Important Bird Areas in the U.S. http://www.audubon.org/bird/iba 04/2010

Nowak, T.J., R.C. Goodwin, and G.B. Brooks. 2010a. Cultural Resources Assessment / Probability Study for the Terrebonne Basin Barrier Shoreline Restoration, Terrebonne and Lafourche Parishes, Louisiana. Draft Report prepared for SJB Group, LLC, Office of Coastal Protection and Restoration, and U.S. Army Corps of Engineers, New Orleans District. R. Christopher Goodwin & Associates, Inc. Frederick, Maryland.

Nowak, T.J., K.A. Ryberg, and K.M. Kuranda, 2010b. Phase I Submerged Cultural Resources Investigation for the Terrebonne Basin Shoreline Restoration Whiskey Island Project Item, Terrebonne Parish, Louisiana. Management Summary prepared for MWH Americas, Inc., Office of Coastal Protection and Restoration, and U.S. Army Corps of Engineers, New Orleans District. R. Christopher Goodwin & Associates, Inc. Frederick, Maryland.

Penland, S., J.R. Suter and T.F. Moslow. 1985. Development and Stratigraphy of Ship Shoal, Northwest Gulf of Mexico, edited by H.L. Berryhill, T.F. Moslow, S. Penland and J.R. Suter, pp. 7-1 to 7-59. American Association of Petroleum Geologists National Meeting Continuing Education Short Course, New Orleans, Louisiana.

Penland, S., and Suter JR,. 1988. "Barrier Island Erosion and Protection in Louisiana: A Coastal Geomorphologic Perspective". Gulf Coast Association of Geological SocietiesTransactions, 38:315-322.

Penland S., Suter JR, and Boyd R. 1988. "The Transgressive Depositional Systems of the Mississippi River Delta Plain: A Model for Barrier Shoreline and Shelf Sand Development". Journal of Sedimentary Petrology. 58:932-949.

Penland, S., P. Connor, F. Cretini, K. Westphal. 2003. "CWPPRA Adaptive Management: Assessment of Five Barrier Island Restoration Projects in Louisiana". Final report submitted to the Louisiana Department of Natural Resources, Office of Coastal Restoration and Management, Baton Rouge, Louisiana. Pontchartrain Institute for Environmental Sciences. New Orleans, Louisiana.

Penland, S., P. F. Connor Jr, A. Beall, S. Fearnley, and S. J. Williams. 2005. Changes in Louisiana's shoreline: 1855–2002. Journal of Coastal Research Special Issue No. 44: 7–39.

Penland, S. and R. Boyd, 1981. "Shoreline Changes on the Louisiana Barrier Coast," in *Louisiana Barrier Islands and Beaches*. Laboratory for Wetland Soils and Sediments, Center for Wetland Resources, Louisiana State University.

Perret, W.S., B.B Barrett, W.R. Latapie, J.F. Pollard, W.R. Mock, G.B. Adkins, W.J. Gaidry, and C.J. White. 1971. Cooperative Gulf of Mexico estuarine inventory and study, Louisiana. Louisiana Wild Life and Fisheries Commission, New Orleans, Louisiana.

Pierce, ME., and Conover, JT. "A study of the growth of oysters under different ecological conditions in Great Pond." Biological Bulletin 107(1954): 318-318.

Reid, WV., and Trexler, MC. "Responding to potential impacts of climate change on United-States Coastal Biodiversity." Coastal Management 20 (1992): 117-42.

Ritchie, W. & Penland, S. 1989. Erosion and washover in coastal Louisiana. Proceedings of Sixth Symposium on Coastal and Ocean Management/ASCE July 11-14, 1989, Charleston, SC, pp. 253-264.

Ritchie, William, K. Westphal, R. A. McBride, S. Penland. 1989. Coastal Geology Technical Report No. 5. Coastal Sand Dunes of Louisiana. The Isles Dernieres. Louisiana Geological Survey, Department of Natural Resources. Baton Rouge, Louisiana.

Ritchie W, Westphal KA, McBride RA, and Penland S. 1990. Coastal sand dunes of Louisiana the Plaquemines shoreline. Louisiana Geological Survey. Coastal Geology Technical Report. 90 pp.

Ritchie, William, K. Westphal, R. A. McBride, S. Penland. 1995. Coastal Geology Technical Report No. 9. Coastal Sand Dunes of Louisiana. Bayou Lafourche Barrier Shoreline. Louisiana Geological Survey, Louisiana State University. Baton Rouge, Louisiana.

Rounsefell, G.A. 1975. Ecology, utilization, and management of marine fisheries. The C.V. Mosby Company, St. Louis, Missouri.

Saucier, M.H. and D.M. Baltz 1993. Spawning site selection by spotted seatrout, Cynoscion nebulosus, and black drum, Pogonias cromis, in Louisiana. Environ. Biol. Fish. 36:257-272.

SCORP. 2003. 2003-2008 Louisiana Statewide Comprehensive Outdoor Recreation Plan. Louisiana Department of Culture, Recreation, and Tourism. Office of State Parks, Division of Outdoor Recreation. Published by Louisiana State Library.

Showalter and Schiavinato. 2004. Marine Protected Areas in the Gulf of Mexico: A Survey. Supported by the National Sea Grant College Program of the U.S. Department of Commerce's National Oceanic and Atmospheric Administration.

SJB Group, Coastal Engineering Consultants, Coastal Technology Corporation, Athena Technologies, and Soil Testing Engineers. (SJB et al.) 2006. Raccoon Island Shoreline Protection/Marsh Creation Project Phase B (TE-48), Offshore Geophysical and Geotechnical Report.

Stone, G.W. and Zhang X. 2001. A Longshore Sediment Transport Model for the Timbalier Islands, Louisiana. Baton Rouge, Louisiana: Coastal Studies Institute Louisiana State University.

Stone, G.W., Pepper, D.A., Xu, J., and Zhang, X., 2004. "Ship Shoal as a Prospective Borrow Site for Barrier Island Restoration, Coastal South-Central Louisiana, USA: Numerical Wave Modeling and Field Measurements of Hydrodynamics and Sediment Transport". Journal of Coastal Research, 20(1), 70-89. West Palm Beach (Florida), ISSN 0749-0208.

Stone, G.W., Zhang, X.P., and Sheremet, A. "The role of barrier islands, muddy shelf and reefs in mitigating the wave field along coastal Louisiana." Journal of Coastal Research Sp.Iss. 44 (2005): 40-55.

Stone, G.W. et al. 2009. Environmental Investigation of the Long-Term Use of Ship Shoal Sand Resources for Large Scale Beach and Coastal Restoration in

Louisiana. U.S. dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS region, New Orleans, LA. OCS Study MMS 2009-024. 278 pp.

Suter, J.R., Berryhill, H.L., and Penland, S. "Delineation of Late Quaternary Depositional sequences by high-resolution seismic stratigraphy, Louisiana Continental-Shelf." AAPG- American Assocation of Petroleum Geologists 71 (1987):620-620.

Suter, J. R., Penland, S., and Ramsey, K. E. 1991. "Nearshore Sand Resources of the Mississippi River Delta Plain: Marsh Island to Sandy Point." Coastal Geology Technical Report No. 8. Louisiana Geological Survey.

T. Baker Smith. 1997. "Evaluation and Recommendation of the Barrier Shoreline Feasibility Study." Houma, La. September 1997.

T. Baker Smith and Moffatt & Nichol (TBS and M&N). 2007. Whiskey Island Back Barrier Marsh Creation (TE-50) 95% Design Report, Appendix B, OSI's Hydrographic, Geophysical, and Geotechnical Survey Program.

Terrebonne Parish Local Coastal Program Advisory Committee (TPLCPAC), 2000. Terrebonne Parish Local Costal Zone Management Program. Houma, Louisiana. April, 2004.

Thompson, B. 1988. Fish and Shellfish, 1988. Isles Dernieres Barrier Island Stabilization project, State Project No. 750-55-01, Draft Environmental Assessment submitted to State of Louisiana Department of Transportation and Development, September 1988. Plaisance/Smith Engineers. Houma, Louisiana.

Thompson, B. A., Forman, W (1987). Nekton. In: Conner, W. H., Day, J. W. Jr (eds.) The ecology of Barataria Basin, CA: an estuarine profile. U.S Fish Wildl. Serv. Biol. Rep. 85 (7.13): 80-96

U.S. Army Corps of Engineers. 2004a. "Louisiana Coastal Area (LCA) Ecosystem Restoration Study." Volume 1: LCA Study – Main Report. November, 2004.

U.S. Army Corps of Engineers. 2004b. "Louisiana Coastal Area (LCA) Ecosystem Restoration Study." Volume 2: Programmatic Environmental Impact Assessment. November, 2004.

U.S. Army Corps of Engineers. 2004c. "Louisiana Coastal Area (LCA) Ecosystem Restoration Study." Volume 4: LCA Study – Main Report. November, 2004.

U.S. Army Corps of Engineers, 2005. Houma Navigation Canal Deepening Project – Terrebonne Parish, Louisiana: Cultural Resources Literature Search, Records Review and Research Design.

U.S. Army Corps of Engineers. 2008. Unpublished. “Project Management Plan. Terrebonne Basin Barrier Shoreline restoration Feasibility Study. Conditionally Authorized Project – Louisiana Coastal Area Ecosystem Restoration Project”. Draft Report. New Orleans, Louisiana.

U.S. Army Corps of Engineers. 2009. Unpublished. “Louisian Coastal Area (LCA) Terrebonne Basin Barrier Shoreline Restoration Feasibilty Study – Scoping Comments”. Draft Report. New Orleans, Louisiana.

U.S. Army Corps of Engineers. 2009b. Water Resource Policies and Authorities Incorporating Sea-level Change Considerations in Civil Works Program. Circular No. 1165-2-211.

U.S. Army Corps of Engineers. 2009c. “Louisiana Coastal Protection and Restoration Final Technical Report”. http://lacpr.usace.army.mil/default.aspx?p=LACPR_Final_Technical_Report

U.S. Department of Agriculture. 2005. “Final Project Plan and Environmental Assessment, Raccoon Island Shoreline Protection/Marsh Creation Project TE-48”, Terrebonne Parish, Louisiana. Alexandria, Louisiana.

U.S. Department of Agriculture, 2007a. Soil Survey Staff. Louisiana State Soil Geographic Data Base (LA-SSURGO) database for Terrebonne Parish, Louisiana. USDA-Natural Resources Conservation Service. Digital Soil Map and Attribute Data.

U.S. Department of Agriculture. 2007b. USDA-Farm Service Agency-Aerial Photography Field Office National Agricultural Inventory Project MrSID Mosaic. United States Department of Agriculture – Farm Service Agency, Salt Lake City, Utah.

U.S. Department of Commerce. 1998. Environmental Assessment of East Timbalier Island Restoration Projects. CWPPRA Projects XTE-67 and XTE-45/67B. Lafourche Parish, Louisiana. Prepared by Gotech Inc., Baton Rouge, Louisiana.

U.S. Department of the Interior. Minerals Management Service. 2004. Environmental Assessment – Issuance of Non-Competitive Leases for the Use of Outer Continental Shelf Sand Resources from Ship Shoal, Offshore Central

Louisiana for Coastal and barrier Island Nourishment and hurricane levee Construction. April 2004.

U.S. Environmental Protection Agency. 1993. “Environmental Assessment for Isles Dernieres Barrier Island Restoration and Coastal Wetland Creation”. Draft. U.S. Environmental Protection Agency Region 6, Dallas, Texas.

U.S. Environmental Protection Agency. 1997a. “Environmental Assessment for Isles Dernieres Barrier Island Restoration and Coastal Wetland Creation (TE-20/TE-24): Finding Of No Significant Impacts”. Terrebonne Parish, Louisiana.

U.S. Environmental Protection Agency. 2000. “New Cut Dune/Marsh Restoration Project (TE-11a/TE-37): Supplement to the Environmental Assessment for Isles Dernieres Barrier Island Restoration and Coastal Wetland Creation”. Terrebonne Parish, Louisiana.

U.S. Environmental Protection Agency. 2002. “Environmental Assessment for Timbalier Island Dune and Marsh Creation Project (TE-40/XTE-45a), Finding of No Significant Impact”. Terrebonne Parish, Louisiana.

U.S. Environmental Protection Agency. 2003a. High Resolution Geophysical and Archaeological Survey of Portions of Blocks 87, 88, 89, 94, and 95 Ship Shoal Area. Whiskey Island West Flank Restoration Project Using Ship Shoal Sediment Coastal Terrebonne Parish, Louisiana. Prepared by C&C Technologies, December 2003.

U.S. Environmental Protection Agency. 2003b. High Resolution Geophysical and Archaeological Survey of the South Pelto Area Block 13 Vicinity of Ship Shoal. New Cut Dune/Marsh Restoration Project Using Ship Shoal Sediment Coastal Terrebonne Parish, Louisiana. Prepared by C&C Technologies, December 2003.

U.S. Environmental Protection Agency. 2005a. “Environmental Assessment for Ship Shoal: Whiskey Island West Flank Restoration (TE-47), Finding of No Significant Impact”. Terrebonne Parish, Louisiana.

U.S. Environmental Protection Agency. 2005b. “Supplemental Environmental Assessment for the Isles Dernieres Barrier Island Restoration and Coastal Wetland Creation West Flank Restoration Project (TE-47)”. U.S. Environmental Protection Agency, Region 6. Dallas, Texas.

U.S. Environmental Protection Agency. 2006. “Biological Assessment for Impacts of New Cut Dune/Marsh Restoration (TE-37) Project on the Threatened Piping Plover”. U.S. Environmental Protection Agency, Region 6.

U.S. Fish and Wildlife Service. 1996. Piping Plover (Charadrius melodus), Atlantic Coast Population, Revised Recovery Plan. Hadley, Massachusetts.

U.S. Fish and Wildlife Service. 2003. "Environmental Assessment: Terrebonne Bay Shore Protection Demonstration Project". U.S. Fish and Wildlife Service, Ecological Service. Lafayette, Louisiana.

Value Management Strategies (VMS), 2009. Value Engineering Study Report, Terrebonne Basin Barrier Shoreline Restoration, Multipurpose Operation of Houma Navigation Lock, Convey Atchafalaya River Water to Northern Terrebonne Marshes

Visser, J. M., and G. W. Peterson. 1994. Breeding populations and colony site dynamics of seabirds nesting in Louisiana. Colonial Waterbirds 17(2): pp. 146-152.

Williams, P.R. 1988. Nekton Assemblages Associated with the Barrier Island Aquatic Habitats of East Timbalier Island, Louisiana. M.S. thesis, Louisiana State University, Baton Rouge, Louisiana.

Williams, J. S., Penland, S., Sallenger, A. H. 1992. "Louisiana Barrier Island Erosion Study, Atlas of Shoreline Changes in Louisiana from 1853 to 1989." U.S. Geological Survey and Louisiana Geological Survey.

Williams, P.R. 1988. Nekton Assemblages Associated with the Barrier Island Aquatic Habitats of East Timbalier Island, Louisiana. M.S. thesis, Louisiana State University, Baton Rouge, Louisiana.

Zimmerman, R.J. 1988. A Survey and Assessment of Usage of a Salt Marsh at Grand Isle, Louisiana by Estuarine Aquatic Fauna. Dallas, Texas. 14 pp.

9.4 GLOSSARY

Acceptability	Adequate to satisfy a need, requirement, or standard. One of the USACE requirements for a project.
Adaptive Management	An interdisciplinary approach acknowledging our insufficient information base for decision-making; that uncertainty and change in managed resources are inevitable; and that new uncertainties will emerge. An iterative approach that includes monitoring and involves scientists, engineers and others who provide information and recommendations that are incorporated into management actions; results are then followed with further research, recommendations and management actions, and so on.
Air Quality Determination	The Louisiana Department of Environmental Quality ensures that projects do not adversely affect air quality through this determination as a requirement of the Clean Air Act.
Alternative Plan	A set of one of more management measures within a subprovince functioning together to address one or more objectives.
Amplitude	The maximum absolute value of a periodically varying quantity.
Anadromous	Ascending rivers from the sea for breeding
Anoxia	Absence of oxygen.
Anthropogenic	Caused by human activity.
Average Annual Habitat Unit (AAHU)	Represent a numerical combination of habitat quality and quantity (acres) existing at any given point in time. The habitat unites resulting from the future without- and future with-project scenarios are annualized, averaged over the project life, to determine Average Annual Habitat Units (AAHUs).
Benefits	Valuation of positive performance measures.
Benthic	Living on or in sea, lake, or stream bottoms.
Biomass	The total mass of living matter (plant and animal) within a given unit of environmental area.
Bottomland Hardwood Forest	Low-lying forested wetlands found along streams and rivers.
Brackish Marsh (BRM)	Intertidal plant community typically found in the area of the estuary where salinity ranges between 4-15 ppt.
Clean Water Act Section 404 (b) (1)	There are several sections of this Act which pertain to regulating impacts to wetlands. The discharge of dredged or fill material into waters of the United States is subject to

	permitting specified under Title IV (Permits and Licenses) of this Act and specifically under Section 404 (Discharges of Dredge or Fill Material) of the Act.
Coastal Zone Consistency Determination	The U.S. Environmental Protection Agency reviews plans for activities in the coastal zone to ensure they are consistent with Federally approved State Coastal Management Programs under Section 307(c)(3)(B) of the Coastal Zone Management Act.
Coast wide Plan	Combination of alternative plans assembled to address an objective or set of objectives across the entire Louisiana Coast.
Collocated Team	A collection of scientists and professionals from the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, NOAA Fisheries, Natural Resources Conservation Service, U.S. Geological Survey, U.S. Environmental Protection Agency, Louisiana Department of Natural Resources, and Louisiana Department of Wildlife and Fisheries that are located at the CEMVN office and work together on the LCA Plan.
Comprehensive Plan	Same as coast wide Plan.
Conditional Authorization	Authorization for implementation of a project subject to approval of the project feasibility-level decision document by the Assistant Secretary of the Army for Civil Works
Congressional Authorization	Authorization for investigation to prepare necessary feasibility-level report to be recommended for authorization of potential future project construction by Congress
Connectivity	Property of ecosystems that allows for exchange of resources and organisms throughout the broader ecosystem.
Continental Shelf	The edge of the continent under gulf waters; the shallow Gulf of Mexico fringing the coast.
Control Structure	A gate, lock, or weir that controls the flow of water.
Cumulative Impacts	The combined effect of all direct and indirect impacts to a resource over time.
Datum	A point, line, or surface used as a reference, as in surveying, mapping, or geology.
Decomposition	Breakdown or decay of organic materials.
Degradation Phase	The phase of the deltaic cycle when sediments are no longer delivered to a delta, and it experiences erosion, dieback, or breakup of marshes.
Deltaic Cycle	The repeating pattern of delta development, progression, and abandonment. As sediments are deposited at the mouth of the distributary channels, the delta progresses seaward. The main channel then switches to a new course with a shorter reach to the depositional basin. Abandoned

	delta lobes decrease in elevation due to continued subsidence and sediment compaction, resulting in retreat of the shoreline. Abandoned lobes may be partially or wholly covered by new lobes during later deltaic cycles.
Deltaic Deposits	Mud and sand deposited at the mouth of a river.
Deltaic Plain	The land formed and reworked as the Mississippi River switched channels in the eastern part of the Louisiana coastal area.
Detritus	The remains of plant material that has been destroyed or broken up.
Dewatering	The process of dredged sediments compacting while losing water after being deposited.
Discharge	The volume of fluid passing a point per unit of time, commonly expressed in cubic ft per second, millions of gallons per day, or gallons per minute.
Dissolved Oxygen	Oxygen dissolved in water, available for respiration by aquatic organisms. One of the most important indicators of the condition of a water body.
Direct Impacts	Those effects that result from the initial construction of a measure (e.g., marsh destroyed during the dredging of a canal). Contrast with "Indirect Impacts."
Diurnal	Relating to or occurring in a 24-hour period; daily.
Diversion	A turning aside or alteration of the natural course or flow of water. In coastal restoration this usually consists of such actions as channeling water through a canal, pipe, or conduit to introduce water and water-borne resources into a receiving area.
Dredged material embankments (Spoil Banks, Side-cast Banks, Excavated Material Banks)	Dredged material removed from canals and piled in a linear mound along the edge of canals.
Dynamic	Characterized by continuous change and activity.
Ecological	Refers to the relationship between living things and their environment.
Economic	Of or relating to the production, development, and management of material wealth, as of a country, household, or business enterprise.
Ecosystem	An organic community of plants and animals viewed within its physical environment (habitat); the ecosystem results from the interaction between soil, climate, vegetation, and animal life.
Ecosystem Restoration	Activities that seek to return a organic community of plants and animals and their habitat to a previously existing or

	improved natural condition or function.
Effectiveness	Having an intended or expected effect. One of the USACE four requirements for a project.
Efficiency	The quality of exhibiting a high ratio of output to input. One of the USACE four requirements for a project.
Egress	A path or opening for going out; an exit.
Embankment	A linear mound of earth or stone existing or built to hold back water or to support a roadway.
Encroachment	Entering gradually into an area not previously occupied, such as a plant species distribution changing in response to environmental factors such as salinity.
Endangered Species	Animals and plants that are threatened with extinction.
Enhance	To augment or increase/heighten the existing state of an area.
Environmental Impact Statement (EIS)	A document that describes the positive and negative environmental effects of a proposed action and the possible alternatives to that action. The EIS is used by the Federal government and addresses social issues as well as environmental ones.
Estuary	A semi-enclosed body of water with freshwater input and a connection to the sea where fresh water and salt water mix.
Estuarine	Related to an estuary.
Evaporation	The process by which any substance is converted from a liquid state into, and carried off in, vapor; as, the evaporation of water.
Exotic Species	Animal and plant species not native to the area; usually undesirable (e.g., hyacinth, nutria, tallow tree, giant salvinia).
Feasibility Report	A description of a proposed action, previously outlined in a general fashion in a Reconnaissance Report, that will satisfy the Federal interest and address the problems and needs identified for an area. It must include an assessment of impacts to the environment (either in an Environmental Assessment, or the more robust Environmental Impact Statement), an analysis of alternative methods of completion, and the selection of a Recommended Plan through the use of a cost-effectiveness analysis.
Feature	A constructible increment of an alternative plan.

Federal Principals Group (FPG)	A collaboration among Federal agencies at the Washington level to facilitate the flow of information, to provide guidance and recommendations to the USACE and LDNR throughout the study process, and to facilitate resolution of any interagency issues that may be identified in the conduct of the study.
Final Array	The final grouping of the most effective coast wide plans from which a final recommendation can be made.
Foreshore Dikes	An embankment of earth and rock built to prevent floods or erosion that is built in the area of a shore that lies between the average high tide mark and the average low tide mark.
Framework Development Team (FDT)	A group of professionals from various Federal and state agencies, academia and the public formed to provide a forum for individual members to discuss LCA Comprehensive Study activities and technical issues and to provide individual comments to the Senior Management Committee.
Fresh Marsh	Intertidal herbaceous plant community typically found in that area of the estuary with salinity ranging from 0-3 ppt.
Furbearer	An animal whose skin is covered with fur (mammal), especially fur that is commercially valuable, such as muskrat, nutria, and mink.
Geomorphic	Related to the geological surface configuration.
Goals	Statements on what to accomplish and/or what is needed to address a problem without specific detail.
Gradient	A slope; a series of progressively increasing or decreasing differences in a system or organism.
Habitat	The place where an organism lives; part of physical environment in which a plant or animal lives.
Habitat Loss	The disappearance of places where target groups of organisms live. In coastal restoration, usually refers to the conversion of marsh or swamp to open water.
Habitat Units (HUs)	Represent a numerical combination of quality (HSI) and quantity (acres) existing at any given point in time. The HUs resulting from the future without- and future with-project scenarios are annualized, averaged over the project life, to determine Average Annual Habitat Units (AAHUs). The “benefit” of a project can be quantified by comparing AAHUs between the future without- and future with-project scenarios. The difference in AAHUs between the two scenarios represents the net benefit attributable to the project in terms of habitat quantity and quality.
Hazardous, Toxic, and Radioactive	Wastes that contain toxic constituents, or that may cause hazardous chemical reactions, including explosive or

Wastes (HTRW)	flammable materials, or radioactive wastes, which, improperly managed may present a hazard to human heath or the environment.
Headland	A point of land projecting into the sea or other expanse of water, still connected with the mainland.
Herbaceous	A plant with no persistent woody stem above ground.
Hydrodynamic	The continuous change or movement of water
Hydrology	The pattern of water movement on the earth's surface, in the soil and underlying rocks, and in the atmosphere.
Hypoxia	The condition of low dissolved oxygen concentrations.
Indemnification	Insurance against or compensation for loss or damage.
Indirect Impacts	Those effects that are not as a direct result of project construction, but occur as secondary impacts due to changes in the environment brought about by the construction. Contrast with "Direct Impacts."
Infrastructure	The basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions including schools, post offices, and prisons.
Ingress	An entrance or the act of entering.
Inorganic	Not derived from living organisms; mineral; matter other than plant or animal.
Interdistributary Deposits	Sand and mud deposited between the river channels or between bayous.
Intermediate Marsh	Intertidal herbaceous plant community typically found in that area of the estuary with salinity ranging from 2-5 ppt.
Intertidal	Alternately flooded and exposed by tides.
Invertebrates	Animals without backbones, including shrimp, crabs, oysters, and worms.
Larvae	The stage in some animal's life cycles between egg and adult (most invertebrates).
Leeward	Sheltered from the wind; away from the wind.
Levee	A linear mound of earth or stone built to prevent a river from overflowing; a long, broad, low ridge built by a stream on its flood plain along one or both banks of its channel in time of flood.
Locally Preferred Plan (LPP)	Alternative plan preferred by local sponsor if other than the Recommended Plan.
Maintain	To keep in existing state.
Methodology	A set of practices, procedures, and rules.
Mineral Substrate	Soil composed predominately of mineral rather than organic

	materials; less than 20% organic material.
Mudflats	Flat, unvegetated wetlands subject to periodic flooding and minor wave action.
National Ecosystem Restoration (NER)	USACE standard for cost-effectiveness based on ecosystem, not economic, benefits.
Near-shore Currents	Movement of water parallel to the shoreline. Usually generated by waves breaking on the shore at an angle other than perpendicular.
National Environmental Policy Act (NEPA)	Ensures that Federal agencies consider the environmental impacts of their actions and decisions. NEPA requires all Federal agencies to consider the values of environmental preservation for all significant actions and prescribes procedural measures to ensure that those values are fully respected.
Net Gain	The amount of cumulative land gain less land loss, when gain is greater than loss.
Net Loss	The amount of cumulative land gain less land loss, when gain is less than loss.
No Action Alternative	The alternative in the EIS which describes the ecosystem of the coastal area if no restoration efforts/projects were done.
Nursery	A place for larval or juvenile animals to live, eat, and grow.
Objectives	More specific statements than "Goals," describing how to achieve the desired targets.
Organic	Composed of or derived from living things.
Oscillations	Fluctuations back and forth, or up and down.
Oxidation of Organic Matter	The decomposition (rotting, breaking down) of plant material through exposure to oxygen.
Oxygen-depleted	Situation of low oxygen concentrations where living organisms are stressed.
Planning Scale	Planning term that reflects the degree to which environmental processes would be restored or reestablished, and the resulting ecosystem and landscape changes that would be expected over the next 50 years. This uppermost scale is referred to as "*Increase*." No net loss of ecosystem function is "*Maintain*." Reducing the projected rate of loss of function is "*Reduce*." The lowest possible scale was no further action above and beyond existing projects and programs.
Post-larval	Stage in an animal's lifecycle after metamorphosis from the larval stage, but not yet full grown.
Potable Water	Water that is fit to drink.

ppt	Parts per thousand. The salinity of ocean water is approximately 35 ppt.
Prime Farmland	Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion. One of the categories of concern in the EIS.
Principles	Framing statements that can be used to evaluate alternatives while considering issues that affect them. Used along with targets and assessments of ecosystem needs to provide guidance in formulation of alternative plans.
Productivity	Growth of plants and animals.
Progradation	The phase during the deltaic cycle where land is being actively accreted through deposition of river sediments near the mouth.
Programmatic Environmental Impact Statement (PEIS)	And Environmental Impact Statement that supports a broad authorization for action, contingent on more specific detailing of impacts from specific measures.
Province	A major division of the coastal area of Louisiana. (e.g., Deltaic Plain and Chenier Plain).
Pulsing	Letting a diversion flow periodically at a high rate for a short time, rather than continuously.
Quantitative	Able to assign a specific number; susceptible to measurement.
Rebuild	To some extent build back a structure/landform that had once existed.
Reconnaissance Report	A document prepared as part of a major authorization that examines a problem or need and determines if sufficient methods and Federal interest exists to address the problem/need. If so, then a "Feasibility Report" is prepared, which details the solution and its impacts further.
Reduce	To diminish the rate or speed of a process.
Regional Working Group (RWG)	An inter-agency team formed to support the Washington-level Federal Principal's Group and to facilitate regional level collaboration and coordination on the LCA study.
Rehabilitate	To focus on historical or pre-existing ecosystems as models or references while emphasizing the reparation of ecosystem processes, productivity and service.
Relative Sea Level Change	The sum of the sinking of the land (subsidence) and eustatic sea level change; the change in average water level with

	respect to the surface.
Restore	Return a wetland to an approximation of its condition or function prior to disturbance by modifying conditions responsible for the loss or change; re-establish the function and structure of that ecosystem.
Saline Marsh	Intertidal herbaceous plant community typically found in that area of the estuary with salinity ranging from 12-32 ppt.
Salinity	The concentration of dissolved salts in a body of water, commonly expressed as parts per thousand.
Salt Marshes	See "Saline Marsh."
Scoping	Soliciting and receiving public input to determine issues, resources, impacts, and alternatives to be addressed in the draft EIS.
Sea level	Long-term average position of the sea surface.
Sediment Plume	Caused by sediment rich rainwater runoff entering the ocean. The runoff creates a visible pattern of brown water that is rich in nutrients and suspended sediments that forms a kind of cloud in the water spreading out from the coastline. Commonly forms at river and stream mouths, near sloughs, and along coasts where a large amount of rain runoff flows directly into the ocean.
Sheet Flow	Flow of water, sediment, and nutrients across a flooded wetland surface, as opposed to through channels.
Shoaling	The shallowing of an open-water area through deposition of sediments.
Social	Relating to human society and its modes of organization.
Socioeconomic	Involving both social and economic factors.
Stabilize	To fix the level or fluctuation of; to make stable.
State Historic Preservation Office (SHPO)	The part of the Louisiana Department of Culture, Recreation, and Tourism that deals with Native American sites and other archaeological/historic sites.
Stillstand	A period of time when sea level did not change.
Storm Overwash	The process by which sand is transposed landward over the dunes during a storm event by waves
Storm Surge	An abnormal and sudden rise of the sea along a shore as a result of the winds of a storm.
Strategy	Ecosystem restoration concept from the Coast 2050 Plan.
Stream Gaging Data	Records of water levels in streams and rivers.
Submergence	Going under water.
Subprovince	The divisions of the two Provinces (see "Province") into smaller groupings: 1) east of the Mississippi River; 2) west of the Mississippi

	River to Bayou Lafourche; 3) Bayou Lafourche to Freshwater Bayou; 4) Freshwater Bayou to Sabine River.
Subsidence	The gradual downward settling or sinking of the Earth's surface with little or no horizontal motion.
Sustain	To support and provide with nourishment to keep in existence; maintain.
Target	A desired ecosystem state that meets and objective or set of objectives.
Terrestrial Habitat	The land area or environment where an organism lives; as distinct from water or air habitats.
Toxicity	The measure of how poisonous something is.
Transpiration	The process by which water passes through living plants into the atmosphere.
Turbidity	The level of suspended sediments in water; opposite of clarity or clearness.
Upland	A general term for non-wetland elevated land above low areas along streams or between hills.
Water Resource Units (WRU)	Stage-damage data developed as part of the Flood Damage Estimation System (FDES) in 1980 for the Mississippi River and Tributaries (MR&T) project were used to estimate the flood damages that are expected to occur in Subprovinces 1, 2, and 3. The data collected for the FDES were delineated into geographic areas with homogenous physical and hydraulic characteristics. These geographic areas were numerically coded and designated as Water Resource Units (WRUs). Within each WRU, land-use elements (structures, cropland, roads, bridges, railroads, etc.) were categorized by location, value, and corresponding depth-damage relationship. The structural damage categories included: residential, commercial, industrial, public, and farm buildings.
Water Resources Development Act (WRDA	A bill passed by Congress that provides authorization and/or appropriation for projects related to the conservation and development of water and related resources.
Weir	A dam placed across a canal or river to raise, divert, regulate or measure the flow of water.

9.5 Acronyms, Abbreviations, Symbols, and Initialisms

AAHU	Average Annual Habitat Unit
ACHP	Advisory Council on Historic Preservation
BFE	Base Flood Elevations

BICM	Barrier Island Comprehensive Monitoring Program
BMA	benthic micro-algae
BMP	Best Management Practices
BRM	Brackish Marsh
BTNEP	Barataria-Terrebonne National Estuary Program
CEMVN	United States Army Corps of Engineers – Mississippi Valley Division, New Orleans District
CE/ICA	Cost Effectiveness and Incremental Cost Analysis
CEQ	Council of Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIAP	Coastal Impact Assistance Program
CoP	Communities of Practice
CPRA	Coastal Protection and Restoration Authority
CWA	Clean Water Act
CWPPRA	Coastal Wetland Planning, Protection Restoration Act
DEQ	Department of Environmental Quality
DO	Dissolved Oxygen
EA	Environmental Assessment
ECO-PCX	Ecosystem Center of Expertise
EIS	Environmental Impact Statement
EOP	Environmental Operating Principles
ER	Engineering Regulation
ESLR	Eustatic Sea Level Rise
E&T	Endangered and Threatened Species
FDES	Flood Damage Estimation System
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FWOP	Future Without Project
FWP	Future With Project
FY	Fiscal Year
GAP	Gap Analysis Program
GIWW	Gulf Intracoastal Waterway
GIS	Geographic Information System
GOM	Gulf of Mexico
GOMESA	Gulf of Mexico Energy Security Act
HEP	Habitat Evaluation Procedures
HNC	Houma Navigation Canal
HQU	Habitat Quality Units
HSI	Habitat Suitability Index
HTRW	Hazardous, Toxic, or Radioactive Waste
IBA	Important Bird Areas

IPCC	Intergovernmental Panel on Climate Change
IWR	Institute for Water Resources
LA	Louisiana
LACES	Louisiana Applied Coastal Engineering & Science
LCA	Louisiana Coastal Area
LDNR	Louisiana Department of Natural Resources
LDWF	Louisiana Department of Wildlife and Fisheries
LERRD	Land, Easements, Rights of Way, Relocation, and Disposal
LGS	Louisiana Geological Survey
LiDAR	Light Detection and Ranging
LL&E	Louisiana Land and Exploration
LOOP	Louisiana Offshore Oil Port
LSU	Louisiana State University
MCACES	Microcomputer Aided Cost Estimating System
MHW	Mean High Water
MMS	Minerals Management Service
MOU	Memorandum of Understanding
MSL	Mean Sea Level
MVD	Mississippi Valley Division
NAVD 88	North American Vertical Datum of 1988
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NGVD 29	National Geodetic Vertical Datum of 1929
NHPA	National Historic Preservation Act
NMFS	Department of Commerce – National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
NRCS	Department of Agriculture – Natural Resources Conservation Service
OCPR	Office of Coastal Protection and Restoration
OCS	Outer Continental Shelf
OMRR&R	Operating, Maintaining, Repairing, Replacing, and Rehabilitating
OSI	Overall Suitability Index
O&M	Operations and Maintenance
OPEC	Organization of Petroleum Exporting Countries
P&G	Principles & Guidelines
PDT	Project Delivery Team
PED	Preconstruction, Engineering, and Design
PIS	Project Information Sheet
PPL	Priority Projects List
REP	Real Estate Plan

ROD	Record of Decision
RSLR	Relative Sea Level Rise
SEIS	Supplemental Environmental Impact Statement
SHPO	State Historic Preservation Officer
SL	Sediment Load
TEC	Theater Engineer Commands
TPCZM	Terrebonne Parish Coastal Zone Management
TY	Target Year
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	Department of Interior – U.S. Fish and Wildlife Service
USGS	Department of Interior – United States Geological Survey
USDA	United States Department of Agriculture
VE	Value Engineering
WMA	Wildlife Management Area
WRDA	Water Resource Development Act
WVA	Wetlands Value Assessment
YOD	Year of Disappearance